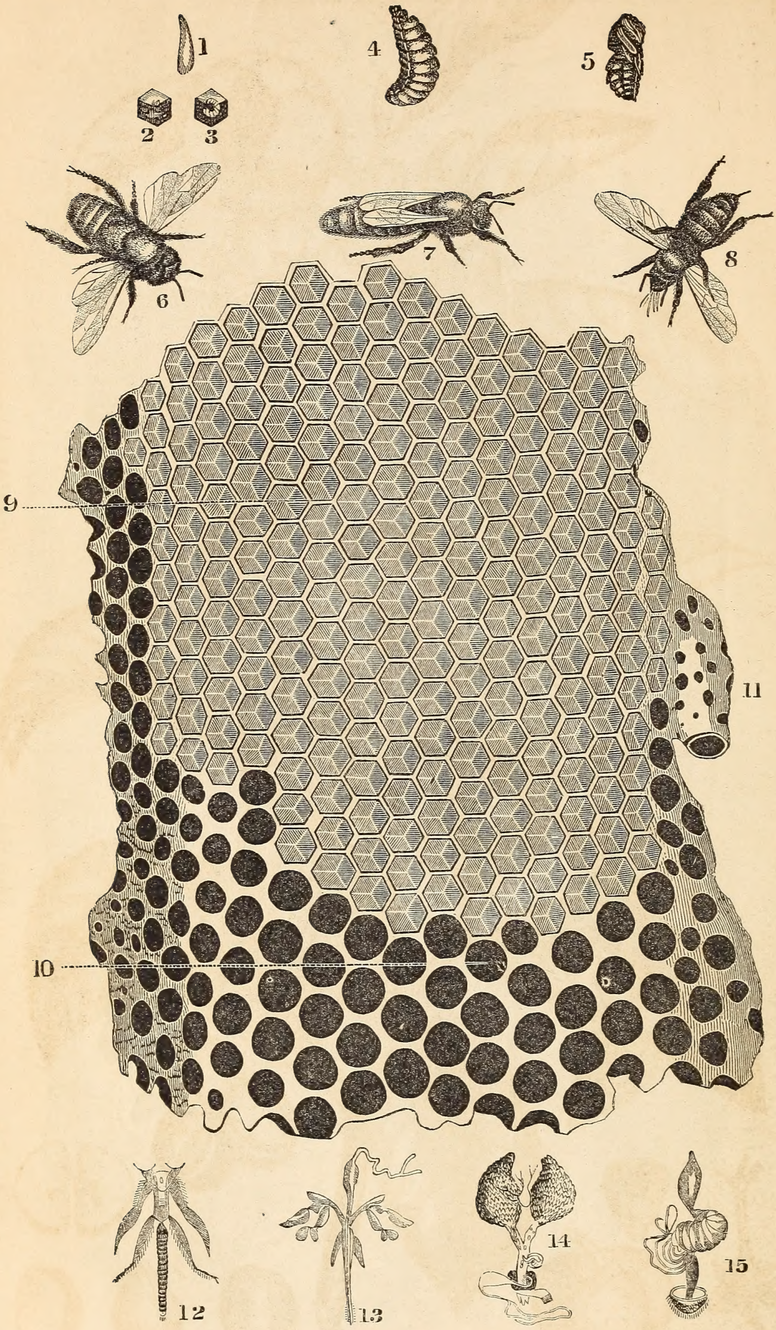
LLAMA. ALPACA.



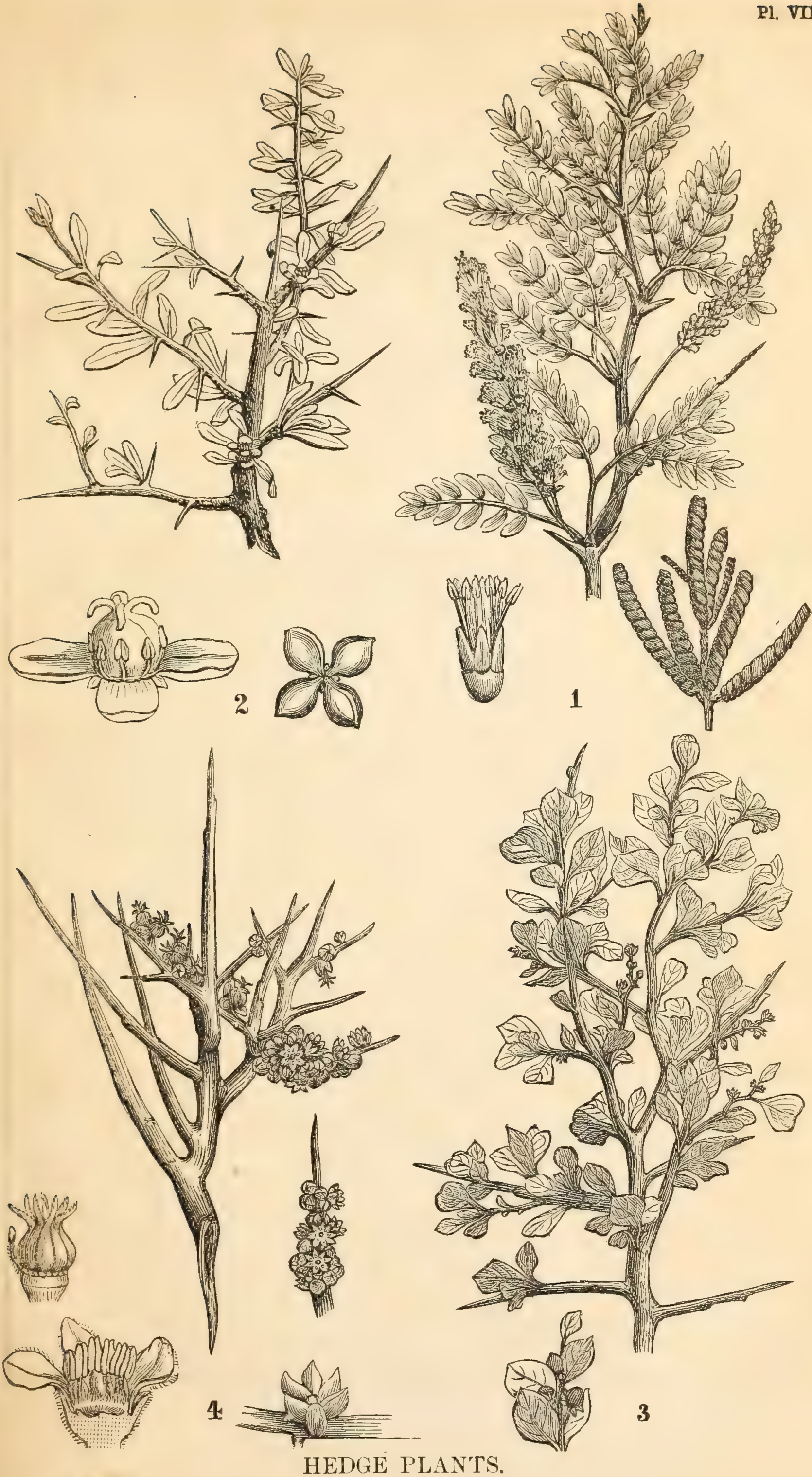
THE HONEY-BEE, ILLUSTRATED.

CHINESE TEA-PLANT.


MAP
INDICATING THE
TEA REGIONS
OF
CHINA AND INDIA
1857.
CHINESE EMPIRE
CHINA
THIBET
HIMALAYA M^TS
LADAK
TEA PLANTATIONS
R. Brahmahpootra
ASSAM
BIRMAH
R. Irawady
R. Saluen
R. Maykiang or Camboja R.
INDIA
Allahabad
Ganges
CALCUTTA
BAY OF BENGAL
GREAT WALL
PEKIN
GREAT CANAL
R. Hoang Ho
R. Yangtse Kiang
YELLOW SEA
COREA
JAPAN SEA
NIPHON
SIKOK
KIUSIN
Shanghae
Chusan I.
Ning-po
Hongchow
Hwuychow
CHEKIANG
Yuk shan
Hokow
Nanchangfoo
Tsong gan hreno
BOHEA M^TS
Foochowfoo
FOKIEN
Amoy
FORMOSA
QUAN TUNG
CANTON
Hong kong
HAINAN
CHINA SEA
LUZON
PACIFIC OCEAN
REFERENCES.
The free ports and British possessions are indicated thus.............Hong Kong
The extreme Limit of the Tea Region is in dotted lines thus.............
80
90
100
110
120
130
40
30
20


MAP
INDICATING THE
REGIONS APPARENTLY ADAPTED
TO THE
TEA CULTURE
IN THE
UNITED STATES
1857
Supposed
TEA REGIONS
of the U.S.
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
MEXICO
UPPER CANADA
LOWER CANADA
N. BWK.
MAINE
VT
NH
MASS.
CON
RI
N. YORK
N. J.
PENN.
DEL
MD
VA.
N. C.
S. C.
GEO.
FLA.
ALA.
MISS.
LA.
TEN.
KY.
OHIO
IND.
ILL.
MICH.
WIS.
IOWA
MIN
MO.
ARK.
TEXAS
KANZAS
NEBRASKA
DACOTAH
N. MEX. T.
ARIZONIA
UTAH T.
ORE. T.
W. TER
CALIFORNIA
L. SUPERIOR
L. MICHIGAN
L. HURON
L. ERIE
L. ONTARIO
L. of the Woods
RIV. ST. LAWRENCE
Mississippi R.
Arkansas R.
Rio Colorado
R. Grande
Rio del Norte
Columbia R.
Great Salt L.
ROCKY MTS.
Waysatch Mts.
Sierra Nevada
SIERRA MADRE
Cascade
Blue Mts.
Alleghany Mts.
C. Flattery
Pt. Conception
Pt. St. Eugenio
G. of CALIFORNIA
Galveston B
C. St. Blas
Charlotte B
C. Sable
Key West
C. Fear
C. Hatteras
C. Henry
C. Charles
C. May
C. Henlopen
C. Cod
C. Sable
B. of FUNDY
N. SCOTIA

MAP SHOWING THE FOREST AND PRAIRIE LANDS OF THE UNITED STATES.



HEDGE PLANTS.

35th Congress, 1st Session. } HOUSE OF REPRESENTATIVES. { Ex. Doc. No. 32.

REPORT

OF THE

COMMISSIONER OF PATENTS

FOR THE YEAR 1857.

AGRICULTURE.

WASHINGTON:
JAMES B. STEEDMAN, PRINTER.
1858

IN THE HOUSE OF REPRESENTATIVES, *May* 19, 1858.

Resolved, That there be printed for the use of the House of Representatives two hundred thousand extra copies of the Report of the Commissioner of Patents on Agriculture for the year 1857, and ten thousand copies for the use of the Patent Office : *Provided*, That the aggregate number of pages contained in said Report shall not exceed five hundred and sixty-eight, including ten pages of illustrations on wood. *And provided further*, That the entire amount of copy necessary to complete said Report be placed in the hands of the Superintendent of the Public Printing on or before the thirty-first day of August next.

Attest: J. C. ALLEN, *Clerk*.

REPORT

OF THE

COMMISSIONER OF PATENTS.

UNITED STATES PATENT OFFICE,
May 11, 1858.

SIR: Agreeably to the design of Congress, as indicated by the appropriation of March 3, 1857, for the collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement and distribution of cuttings and seeds, I have the honor herewith to transmit the agricultural portion of my Annual Report.

The success which has heretofore attended the operations of this Office in collecting and promulgating facts connected with the history, progress, and economy of the principal staples that form the basis of our national wealth, in procuring and disseminating new and useful products throughout the land, and the increase and extension of such as have been of limited and local culture in the different sections, respectively, has practically demonstrated that the expenditures for these objects have been judiciously made, and commends the expediency of continuing these appropriations for similar purposes.

Among the objects of interest which have been under investigation for several years may be mentioned the enlistment, in connection with the Smithsonian Institution, of more than three hundred meteorological observers throughout the Union, who have been furnished with appropriate instruments for the purpose of determining the mean monthly temperatures, as well as the extremes of heat and cold, and amount of rain, with other phenomena, at the various stations. In connection with the same Institution, meteorological and geological maps have been constructed for determining the regions which would seem best adapted for the culture of tea, and other products, as compared with the countries in which they are indigenous.

An agent has been employed to visit the tea districts of China, for the purpose of collecting the seeds of the tea shrub, and of other plants; and is instructed to return with them to the United States early in 1859, when he is expected to make choice of localities for their cultivation. This gentleman, it may be stated, was selected as being peculiarly qualified to carry this enterprise into successful operation. He had been previously sent to China, some ten or twelve years ago, by the London Horticultural Society, where he wandered for three years in the interior, collecting seeds and plants, which have proved a great acquisition to the gardens of Europe, and in some degree to those of this country. In 1848, he was employed by the British East India Company to revisit the tea districts, to collect the seeds of the tea plant, and to introduce them into the Himalaya, in which last mission he was eminently successful. It is shown on a subsequent page of the present Report that it has already been ascertained that many portions of the United States, in respect to soil and climate, are well suited to the cultivation of this plant, and that, with improved apparatus, and other appliances of American skill, the leaves can be manipulated, or otherwise converted into tea, at an expense less than the actual cost of similar preparations in China, even with the low-priced labor of the Asiatics. From the character of the person selected for this duty, his intelligence and experience, as well as the clear understanding he possesses of the desires of this Office, no doubt can reasonably be entertained with respect to the satisfactory discharge of all the duties of his mission; and if success shall attend the vessels bearing the seeds or plants to our shores, a new branch of agricultural industry may be confidently anticipated.

The services of an able chemist have been secured to make investigations in the quantitative analyses of the cotton plant and the soils in which it grows, researches on the Chinese and African sugar-canes in reference to the amount of alcohol and saccharine matter contained therein, as well as of the nutritive properties of the Chinese yam, the common potato, chufa, and of Indian corn. The results of these investigations, it is believed, not only throw new light on science, but will prove, on further inquiry, of value in the production and economy of these plants.

Other chemists were also consulted or employed in different parts of the Union, to determine practically the feasibility of crystallizing the juice of the Chinese sugar-cane—a question, as will be seen, which has been fully and satisfactorily solved and put at rest.

An agent was also employed during the past season to visit Arkansas, Texas, and the neighboring Territories, for the purpose of selecting cuttings of the native grape-vines, with a view of testing their adaptation to wine-making and for table use in various sections of the Union. In his journeys over a vast extent of country, travelling much of the distance on foot through regions wild, rugged, often without roads, and presenting no shelter to the wayfarer, even at night, he succeeded in collecting several thousand cuttings of the best varieties of vine indigenous to those tracts, which have been placed in proper hands for direct experiment in various localities, as well as in the forcing-house of Government on the public grounds in Washington, in order that they may take root preparatory for future distribution.

The manufacture of wine from our native grapes, it is well known, was practised not only by the French settlers on the Illinois river, but by several of the Indian tribes, who regaled themselves with the "must," or juice of wild grapes. Experiments in wine-making, both with the European grape and our own species, have also been made at various periods in other parts of the territory of the United States; but the designs of those interested have never been brought to perfection with the foreign grape, California and New Mexico excepted, owing, it is believed, to the unsuitableness of our climate, which, on the contrary, is favorable to the native varieties. Notwithstanding these difficulties, many patriotic individuals have persisted in the endeavor to make this a wine country by establishing nurseries and vineyards, their motives, in many instances, doubtless being influenced by a desire to promote the cause of temperance, and consequently of health and happiness. The past experience of the world has shown that inebriety, and the attendant evils produced by the use of distilled and factitious liquors, as beverages, disappear in proportion as pure wine becomes accessible to the people.

Within the territory of the United States, it has been stated that there are at least forty well-defined botanical species, including

upward of one hundred varieties of native grapes. More than half of these are susceptible of being converted into a wholesome wine, either alone or with the addition of sugar. and among these only some ten or twelve varieties are sufficiently palatable for table use. All, doubtless, would flourish near their native sites, and many of them, probably, would succeed well, and improve in the qualities of their fruit, if transferred to other States. It has been recommended that the best varieties of the Northern grapes, which mature early in August, might be cultivated in the Middle and Southern States, with the view of obtaining them several weeks earlier than the varieties already existing in those regions.

One of the greatest checks to this species of culture in this country has been the time required for the grapes to produce well, often being from three to six years. Farmers and others, who could conveniently engage in it, have been impatient to have yearly returns in their crops, and have been unwilling to wait for the vines to come into bearing. Another obstacle has been the difficulty and expense of procuring cuttings or roots. Were they to propagate vines from seeds of the wild grape, they would never be sure to produce fruit of the same quality, as a new variety will often be the result; and, besides, many of those thus cultivated would prove sterile or male vines. Moreover, a seedling vine, unless grafted, will not bear fruit until it is five, ten, or perhaps fifteen years old, while cuttings will bear in from three to five years. Again, the process of hybridizing the European grape on our native species is a somewhat difficult one, as well as long and tedious. And finally, the greatest discouragement has arisen from the want of a knowledge of the principles of vinification, which has so often resulted in the production of inferior or worthless articles—not wines, but unwholesome factitious mixtures.

The entomologist employed by the Office confined his researches during the past season principally to the insects frequenting the cotton plant, and the diseases affecting it in Mississippi and Tennessee. At present, he is employed in Florida, in the regions of St. John's River, in prosecuting his inquiries and experimenting upon the insects which infest the orange groves and cotton fields. His labor, it is believed, will be fraught with much benefit to planters, and to the country at large.

Among the seeds, cuttings, and tubers which have been introduced from abroad, or have been made the subject of experiment in this country since the date of the last Annual Report on Agriculture from this Office, it may be stated that—

The cuttings of the sugar cane—imported from Demerara by government for the planters of the South promise to attain a large size, and, should they prove sufficiently hardy to withstand the climate of the regions where they are intended to grow, it is believed that they will amply compensate in the end for the trouble of introducing them.

In addition to the large amount of Chinese sugar-cane seed cultivated and distributed towards the close of the last year, more than one hundred bushels of the seed of this plant were imported from France, and distributed throughout the cultivated parts of our territory for experiment. Sufficient returns have been made to convince us that this new product will prove of incalculable value for feeding stock, and promises fair to be of other economical use in all situations where the corn-plant will thrive.

The success attending the culture of the Chinese yam has also been such as to warrant us in stating that it is well adapted to our soil and climate; but how far it can be depended upon as an alimentary basis as a substitute for the common potato can only be determined by further experiments. The aspersions and prejudices which have been advanced against this esculent for the last two years have probably arisen from a want of knowledge of its habits and the disadvantages under which it has often been grown. For instance, most of the plants which have been propagated in this country have been started from the small tubers, or pseudo bulbs, taken from the vines of the preceding year. These, in many cases, probably, did not possess sufficient substance to maintain the vitality of the plants, and even when they did, it was in so feeble a degree as not to allow the growth of the roots to make much progress before the second year. Several tubers have been presented to this Office exceeding two feet in length and weighing nearly two pounds each.

Among the Cereal grains distributed by the Office in the course of the past summer, I would instance several varieties of wheat obtained from the shores of the Mediterranean, and a quantity of bald barley from Tuscany, which, it may reasonably be expected, will succeed in many localities where they have been sown.

Having thus endeavored to carry out what he believed to be the intention of Congress in making the appropriation for agricultural purposes, the undersigned herewith presents the results which have been attained during the past year.

All of which is respectfully submitted.

J. HOLT,
Commissioner.

Hon. James L. Orr,
Speaker of the House of Representatives.

PROGRESS OF AGRICULTURE.

PROGRESS AND PUBLIC ENCOURAGEMENT OF AGRICULTURE IN RUSSIA, PRUSSIA, AND THE UNITED STATES.

BY D. J. BROWNE.

ALTHOUGH it is a well established axiom in political economy that the wealth and material welfare of nations, upon which their power and financial prosperity depend, are primarily determined by the productive forces each country possesses within itself, it is conceded that the effects of institutions—social, economic, or administrative—have done more to increase their industrial interests than all other moral and political causes combined. In common language, we often hear a country spoken of as agricultural, manufacturing, or commercial; but these terms imply only relative values, which serve to indicate the degree of importance occupied in a given territory by one or other of these three branches of productive industry, or rather the degree of development at which its industry or commerce has arrived; for at all times and in all countries, agriculture, the "nursing mother of nations," forms the basis of wealth and prosperity, and the plough, in its modest guise, plays the principal part in the creation of values, even in countries the most commercial and industrial. Of this, England furnishes a most notable example: In the scale of nations, she is decidedly the most commercial, as well as the most industrial—her trade and industry forming the basis of her power; and yet, it appears from the returns of her income-tax that the net revenue of all her manufactures and commerce, and of all her personal capital, does not exceed two-thirds of the net revenue derived from her agriculture alone. From this single fact, we may infer the degree of pre-eminence which should be attributed to the agricultural element of national wealth.

In proceeding to the subject immediately before us, namely, the encouragement of agriculture in some of the leading countries of the globe, it may be stated that, from the rapid advancement of this science under the mere influence of an increasing population and a more diffused intelligence, aside from all intrinsic causes, such as the infinite variety of industrial products, the unprecedented progress which industry has made within the last quarter century, the tribute

so largely paid to it by the exact and natural sciences, the ingenious inventions that have augmented its productive forces, the wonderful mechanisms by means of which it has rendered tributary the physical powers of Nature to spare the labor of animals as well as that of man, it is not surprising that the attention of governments, as well as of individuals, should have been directed towards the encouragement and improvement of farming pursuits. A more careful and exact inquiry into their guiding principles has been instituted, and a desire manifested to give them an elementary and communicable shape, so far as might be found practicable for the benefit of those who should be interested in their study. But the growing estimation, popularity, and widely extended adoption of agricultural pursuits among all grades of society, in both hemispheres; the distribution of books and other publications, treating on the subject; the formation of numerous associations, special and general, for its promotion; and the constant activity of discussion which has ensued, have all tended to draw towards it a degree of attention and scrutiny, probably unprecedented in the history of mankind. By the appliances and improvements which have resulted from modern art and discovery, forests have been cleared; marshes and lakes drained and converted into arable fields; hill-sides and plains made fertile by irrigation; useful products introduced or improved, and their properties recognized, represented, and compared with those of the soils in which they grew; telegraphs have been extended from zone to zone; seas united; continents traversed by rail-roads and canals, and oceans navigated by steam. Political changes and the combined efforts of individuals, as well as of States, have also contributed to infuse into it a warmth of discussion, which, whatever its present effects, cannot fail to be regarded as one of the most powerful vehicles of information and corrected views. Thus nations have become more intimately connected; their arts, commerce, and manufactures increased, which, from the great extent of their influence, have caused the various countries reciprocally to respond to each other with all their attendant advantages and blessings.

In presenting the following accounts of the encouragement given to agriculture by some of the principal governments of Europe, the writer wishes it to be understood that it has not been done with the idea that all which has been practised by our brethren beyond sea is applicable to our own husbandry or economy, nor with the expectation that it will be imitated by us; but they are simply offered with the view of enabling us to compare some of the public operations of agriculture in the Old World with those of the New, which, it is believed, will prove suggestive in enlarging the fields of labor of the Agricultural Societies in the United States.

ENCOURAGEMENT OF AGRICULTURE IN RUSSIA.

It has been asserted that no empire but Russia "ever succeeded in keeping so vast a portion of the globe a secret and a mystery

to the rest of mankind." There does not seem to be a just cause, however, for imputing to that apparently anomalous country any such intention ; nor is it easy to perceive any motive which should induce her to entertain it. Whatever may be the mysteries of her diplomacy, it is found that those publicists, who have restricted their inquiries to an analysis of the effective components of her material welfare, do not complain that there is any department of her statistics in which secrecy is either maintained or desired, with the exception, perhaps, of that of her finances, as to which she certainly has not been unnecessarily communicative. On the contrary, it would appear that, for the last quarter century, at least, the Russian government has not only made great exertions to obtain correct information with regard to the condition and resources of the empire, but has taken pains, at no small expense, to diffuse this information among its subjects, and to excite among them a desire for its acquisition. For this purpose, reports from the various ministries, appertaining to matters concerning their respective departments, have been published at frequent intervals, and chairs of statistics established in the several universities. In 1843, for instance, the "Materials for a Statistical Account of the Russian Empire" emanated from the Ministry of the Interior ; the official "Tables of Commerce," also, which have appeared annually for upwards of fifty years, contain more information than is to be found in the analogous documents of most other European States ; and, altogether, scarcely a month or a week passes without some valuable contribution to the knowledge of the country issuing from the press through one or other of the official journals.

The collection of agricultural statistics commenced as early as 1803, under the Ministry of the Interior, and continued until the establishment of the Ministry of Domains, in 1837, from which period to the present, the latter has been sedulously engaged in taking and arranging them. The facts are furnished by the heads of the several governments and those of the crown lands—by the inspectors of agriculture—by the societies—by agents sent to different parts of the country—by commissions for effecting an equalization of the different classes of peasants—by the professors of the Institute of Goirgoretzk—by the correspondin gmembers of the Scientific Committee of the Department of Rural Economy—and, finally, by the answers to prize questions. The varied information thus obtained is published under the direction of the Department of Rural Economy.

The diffusion of knowledge by means of the press, in Russia, it may be remarked, has also been recognized as one of the most effectual means of promoting the improvement of agriculture. In 1802, the Emperor Alexander manifested a desire to see the Academy of Sciences systematically engage in publications, derived from periodical literature and foreign works, on all agronomic inventions and improvements of recognized utility. From this period, date the numerous agricultural publications which have been issued at public expense. In 1830, the practice was introduced into most of the governments of issuing periodical publications under the title of "Goubernskïa Vedomosti," (government news,) containing useful hints in matters of

agriculture, industry, and commerce. In 1834, there was established, at the expense of the State, an Agricultural Gazette, of which a certain number of copies is distributed gratuitously to the village clergy. The whole number of this paper is about five thousand copies. Since 1841, the Ministry of Domains has issued a monthly journal of its operations, containing also essays on various subjects connected with rural economy, as well as information appertaining to agricultural improvements both at home and abroad. Another Agricultural Gazette, in the German language, has been published at Odessa, since 1846, by the Colonial Protection Committee, especially intended for the colonists in the south of Russia. There are also published, under the superintendence of the Scientific Committee of the Ministry of Domains, and by some of its members, useful works on various branches of agriculture, of which several are devoted to the moral and agricultural instruction of the peasants.

The impulse thus given by government roused the literary activity of the enlightened classes in different parts of the empire, and within the last ten years publications on agricultural affairs are yearly becoming more numerous. The Imperial Independent Society of Rural Economy, at St. Petersburg, now issues three journals, one monthly and one weekly, in the Russian language, with a circulation of six thousand five hundred copies ; and the other in the German, appearing once in two months, with a circulation of one thousand two hundred copies, two hundred of which go to foreign countries. The Transactions of the Jaroslaw, the Southern, and other agricultural societies, which have no annals of their own, are published in the above-named journals, each society being furnished with a stipulated number of copies for its own use. Besides these journals, the society has printed and published, at its own expense, a "Course of Technical Chemistry ;" a "Description of Mineral Waters ;" a treatise on the "Protection of Cattle from Disease ;" and "Etudes Entomologiques," the latter of which comprises monographs and reports on entomological investigations in Russia, so far as they relate to agriculture, whether the insects are injurious, beneficial, or specially adapted to the use or luxury of man. With the object of diffusing knowledge throughout the empire, the society recently distributed four thousand two hundred and ninety-four volumes among educational institutions, libraries, and agricultural associations, a portion of which comprised its own publications. This society also receives, by way of exchange, upwards of seventy journals or transactions from the societies of foreign countries with which it has intercourse, and is presented with all the publications issued in the empire.

Since 1842, the Scientific Committee of the Ministry of Domains has offered gold and silver prize medals for the solution of important questions connected with Russian agriculture, by ascertaining the causes which impede the progress of any particular branch, and suggesting the best remedies. The successful essays are published in the Journal of the Ministry. Shows of agricultural products are held in several of the governments, and prizes awarded to promote the improvement of rural economy by stimulating competition. These

shows—the first of which were held at Odessa and Jaroslaw, in 1844—serve also to exhibit the progress which agriculture actually makes in the different provinces.

Within the last seven years, there has been issued a physical and industrial chart of European Russia, as well as several of its governments, indicating the climate, soil, products, mines, manufactories, internal improvements, imports, exports, valuations, &c., which contain a vast amount of information nowhere else to be found in so concise a form.

In attempting to provide express seminaries for agricultural education, more activity has been manifested in Russia, perhaps, than in any other country of Europe. Under the Emperor Paul, near the close of the last century, the idea of imparting special instruction in husbandry was formed, and the first practical school of agriculture founded about fifteen miles from St. Petersburg. Another school was established near the same city in 1804, under the patronage of the administration of the Appanages, and organized in a manner exceedingly appropriate to the wants and social condition of the agricultural population. In that school, theory is adapted to the capacities and education of the students, and closely followed by practical instruction, which is made to extend not only to the tilling of the soil and the rotation of crops, but also to the trades most useful for the rural classes, as the weaving of linen, the preparation of leather, the making of wearing apparel, and various implements of the household.

In 1832, there was founded a special Seminary of Agriculture for the peasants of the Appanages, in the neighborhood of St. Petersburg, on the north bank of the Neva. Of the serfs owned by the Emperor, a certain proportion were annually sent to this school for the purpose of being educated in all the practical details of farming operations, according to the climate and necessities of the districts into which they are afterwards to be detailed. Modern implements of the most approved construction are provided, and the pupils instructed in their use. The term of tuition, or rather of service, is limited to five years, and classes of sixty are annually sent out to farms in different parts of the empire, carrying with them into its remote provinces such knowledge and skill as a compulsory system of training has bestowed upon them. The expense is privately defrayed by the Emperor, and the project, it is stated, has resulted in success.

In 1834, an Agronomic Institute was established at Dorpat, for superior instruction in the various branches of rural economy; and in 1840, another, on a grand scale, in the government of Mohilew, on the domain of Gorigoretzk, belonging to the crown. A capital of about 38,580 rubles ($28,935) and a considerable tract of land, with an agricultural population of 2,735, were appropriated to this establishment, which is divided into two departments—one of inferior instruction, for simple cultivators, with the view of enabling them to carry out the praxis, and the other of a higher order, for the special purpose of training agriculturists for the management of large estates, and introducing upon them improved systems of husbandry.

Annexed to this institution is a farm for the practical instruction of simple peasants.

Establishments for special instruction in various subsidiary branches of rural economy have also been founded in different parts of the empire, such as forest institutes, schools of viticulture, gardening, bee-culture, sheep-raising, &c., and have been attended with good results.

At the period of instituting the first agronomic schools, the idea was conceived of creating model establishments of rural economy. In 1801, a model farm was founded in the government of Smolensk to facilitate the introduction of an improved cultivation in the Appanage Domains; and in 1802, a similar establishment, termed the "English Farm," was founded near St. Petersburg; but both were suppressed shortly afterwards, in consequence of their expense so greatly exceeding the value of any benefit which seemed likely to be derived from them. At that period, the agricultural classes in Russia, it was found, were not sufficiently familiar with the mere elements of a rational system of culture to be able to appreciate their advantages. But this first want of success did not prevent the Emperor from again directing his attention to the subject. In 1825, the Minister of Finance was authorized to institute model farms in those districts where it was thought they might be the most useful, appropriating to each a foundation capital of 50,000 rubles ($37,500) and an annual rent of 15,000 rubles ($11,250.) By virtue of this authority, a farm was established at Lougansk, in the government of Ekathérinoslaw, which was afterwards suppressed for local reasons, and replaced by another founded in 1848, in the same government, on an estate belonging to the crown, in the district of Alexandrowsk. Besides this farm, others have been established in the governments of Wologda, Saratow, (two,) Tambow, Mohilew, Kazan, and Khrakow. The lands appropriated to these eight farms occupy an area of 10,490 dessiatines (28,220 acres.) Both crown and private peasants are admitted as pupils into all. In 1849, the number of pupils was 706, but is annually increasing. A complete course of studies occupies four years, in which different systems of agriculture are taught, each being appropriate to the particular circumstances of the region where the farm is situated.

With the view of diffusing agronomic knowledge among the peasantry through the instrumentality of the village curates, the government has introduced a course of agriculture into the seminaries which send to the institute of Gorigoretzk pupils intended to become professors of this branch of instruction; and the Ministry of Domains has since published a complete course of agriculture specially designed for the students. These curates, who belong to the dominant church, have considerable endowments in land, well arranged, and every way suitable for converting into little model farms; and an improved system of culture, seen in operation on the curate's glebe, cannot fail to exert a favorable influence upon the whole parish, to say nothing of the good counsels which an intelligent parson may be able to impart.

But one of the most effectual means of conveying agricultural knowledge in Russia, and which has been recognized in every civil-

ized country, is by agricultural associations. They afford farmers the means of suggesting improvements, as well as a channel for communicating to each other the results of their observations and experiments, and of securing the general benefits of their respective knowledge. The first Russian association of this kind, the Imperial Independent Society of Rural Economy, at St. Petersburg, was instituted under the auspices of the Empress Catherine II., in 1765, at a period when there were not half a dozen societies of this description in all Europe. At first, it received from the Empress 6,000 rubles ($4,500) for the erection of a building. Subsequently, Alexander I. granted 5,000 rubles ($3,750) per annum to defray the necessary expenses. In 1826, the Emperor Nicholas increased this sum to 15,000 rubles ($11,250.) The next year, he granted to the society an annual contribution from the general imposts or taxes of the country for the diffusion of vaccination. In 1833, there was also bestowed an annual donation of 20,000 rubles ($15,000) for agricultural education. Besides these sums, he ordered an annual payment of 7,000 rubles ($5,250) instead of lands which had previously been endowed to the society. Another feature worthy of note is, an annual appointment, made on the recommendation of this association, of a suitable agent to travel in foreign countries five months each year, to report on the condition and progress of agriculture and manufactures, who receives his instructions from the council of the society, and enjoys certain privileges granted by the government during the mission.

Under the reign of Alexander I., the Agricultural Society of Livonia was founded, in 1805, and that of Moscow, in 1818. Since that period, several others have been formed in the Baltic provinces, in the south of Russia, as well as in some of the central governments. At present, the number of societies in Russia amounts to about twenty, among which may be particularized the Agronomic Society of Moscow, the Central Society of Sheep-Farming, (also at Moscow,) and the Agronomic Society of South Russia, at Odessa.

In 1836, the Technological Institute of St. Petersburg was established, containing a cabinet of models of agricultural implements and machines, duplicates of which are transmitted to the Chambers of Finance of every government for the purpose of forming collections. The manufacturers of agricultural machinery at Moscow have also received pecuniary subsidies to enable them to extend their establishments. These measures, it is stated, exert a favorable influence on agricultural progress.

ENCOURAGEMENT OF AGRICULTURE IN PRUSSIA.

The administration of the entire domain of agriculture in Prussia is conducted by a Department of Agriculture, under the direction of a Minister, whose jurisdiction embraces the government of the authorities charged with the execution of the laws established for effecting an immunity both from tenant-rights and such rents and tithes as are an obstacle to a proper and advantageous use of real estate; the

division of real estate held jointly; the granting of rights of possession, redemptions, &c.; the administration of the laws for the protection of forests and fields, game and fish, and riparian rights; the regulation of drainage and dykes, the public studs, and the institutions for agricultural education, as well as the direction of the societies for the improvement and encouragement of agriculture and rural economy.

Subordinate to the Department of Agriculture is the Board of Rural Economy, constituting a technically advisory authority, which is especially charged with the direction of the agricultural societies. It was organized in 1842, and is composed at present of a president, secretary, and a board of ten consulting members, some of them being practical agriculturists, while others are well versed in various branches connected with the subject, among whom is the Director of the Bureau of Statistics, which is subordinate to the Department of the Interior, and charged with taking the general, as well as the agricultural statistics of the country. In the transactions of this board, the members individually discourse or write upon such subjects as they are best fitted by their knowledge and ability. The board is furnished with regular reports from the societies, and again it submits its own reports to the Minister of Agriculture. It also publishes, in monthly numbers, the Annals of Agriculture, containing its own transactions and such other articles as are deemed useful and worthy of diffusion.

The support afforded by government to agriculture consists, therefore, in the extensive and judicious organization of its department, its proper legislation, agricultural education, liberal appropriations, and temporary advances of money, together with such other measures as are adapted to its general encouragement. The societies themselves are distributed over the nine provinces of the kingdom, which contains about 17,000,000 inhabitants, and embraces an area of 107,960 square miles. In each province there is one central or general society, or more, surrounded by subordinate societies, to which again, in some cases, are attached minor clubs or associations. Aside from this centralization, there are other societies, having no connection with the above, all, however, acting under the direction of the Board of Rural Economy. The central societies exercise a general superintendence, direction, and control over the subordinate and minor ones, encouraging and aiding them, suggesting and assisting in agricultural improvements and education. Each central society has a fund, to which all the respective subordinate societies contribute, to defray the expenses incurred in furnishing agricultural information, in holding exhibitions, and in the general advancement of their common interests. Collectively, they promote the common cause, by meetings and exhibitions, by distributing publications and seeds, by establishing schools, experimental farms, and trial grounds, as well as by other institutions appertaining to the promotion of this great branch of national prosperity.

The following table exhibits the distribution, membership, and annual expenditures of the several societies in the kingdom:—

Distribution, membership, and expenditures of the several societies.

Provinces.	Number of central or general societies.	Number of subordinate and minor societies.	Number of independent societies.	Number of members.	Annual expenditures.
Prussia	4	79	13	3,665	$6,144 00
Poland	1	9	13	1,780	7,491 20
Pommerania	2	27	2	1,724	2,825 60
Brandenburg	3	32	11	4,140	12,515 20
Silesia	1	42	11	5,848	7,417 60
Saxony	1	48	13	4,647	6,684 00
Westphalia	5	34	4	6,611	5,773 60
Rhenish Prussia	1	47	5	11,088	11,066 40
Hohenzollern	1	4	....	1,116	322 40
Total	19	322	72	40,619	60,240 00

Accordingly, the whole number of societies in Prussia is four hundred and thirteen; those of the other parts of Germany, as far as they could be ascertained, being about one thousand, or fourteen hundred and thirteen in all.

The annual expenditures of the various societies are derived from the following sources:

Fees and contributions	$44,660 80
Income from lands and loans	1,913 60
Donations from insurance and other companies	3,030 40
Other donations	1,488 00
Proceeds from gardens, nurseries, experimental farms, sale of publications, exhibitions, &c	9,147 20
Total	60,240 00

This sum, aside from the appropriations and temporary advances made by the government, is annually devoted by the societies to agricultural purposes.

The following are the periods at which some of the societies were established:

The year 1772 gave birth to the first agricultural society, which was followed by the organization of another in 1791; so that, prior to the year 1801, there were only two societies in the kingdom. The next twenty years, from 1801 to 1820, being an unfavorable period to agriculture, in consequence of the raging wars, called forth only eight societies, while the ten succeeding years, from 1821 to 1830,

favored by the blessings of peace, brought into existence twenty-three, a number which, during the eleven years, from 1831 to 1841, under the continued influence of peace, was raised to one hundred and nine. The next period, embracing the four years from 1842 to 1845, the commencement of which is distinguished for the establishment of the Board of Rural Economy, shows the formation of eighty-five societies, followed by an increase of seventy-five during the five years ensuing. From that time, up to 1855, there was an addition of one hundred and eleven societies.

This statement shows that there were one hundred and forty-two societies organized prior to the establishment of the Board of Rural Economy, in 1842, while the number formed after that time amounts to two hundred and seventy-one—certainly a gratifying increase, and no doubt greatly owing to the energy and beneficent influence, both directly and indirectly, emanating from that board, and the general administrative organization of the agricultural affairs of the country.

Among these societies may be instanced the following, designed for special objects:

	No. of Societies.
Horticulture	13
Breeding, rearing, and management of horses	13
Bee-culture	12
Cultivation of forests	8
Wine-culture	1
Fruit-culture	5
Silk-culture	20
Flax and hemp-culture	3
Cultivation of beet-root	1
Collection, trial, and exhibition of the best agricultural implements and machines	1

Besides the above, there are a number of teachers' and villages' agricultural associations; also, seventeen societies for the improvement of the moral and social condition of servants; and an agricultural work-house to afford practical and theoretical training to orphans and other children in want of care. There are also several agricultural banks for savings, as well as exchanges for ascertaining the best modes of selling products and providing for the protection of the interests of mechanics. There are four societies for the embellishment of private and public grounds; joint-stock companies for draining and improving grass-lands; agricultural fire and cattle insurance societies, as well as companies for the importation of breeding animals.

It may be stated, moreover, that agricultural machinery receives a large share of attention from the government and societies in loans and donations of money, as well as in premiums and provision for the education of mechanics. There are fifty-five establishments of large size, worked either by steam or water-power, in the manufacture of machines, and twenty-eight smaller ones, principally engaged in repairing.

Among the societies, there are some which purchase and sell ap-

proved implements and machines to their members; while others cause them to be manufactured for gratuitous distribution. Of these, they possess some fifty-six cabinets of working models, including numerous machines for the manufacture of drain-tiles, for the use of members. Some of the societies own property, others lease grounds or hold public property in charge or trust for agricultural and experimental purposes. A number of them are also provided with collections of wool and Cereals, models of fruit, herbariums, mineral cabinets, chemical apparatus, philosophical instruments, designs, drawings and paintings of agricultural objects. The societies have, in the aggregate, some seventy-three libraries, for the benefit of the members, used either gratuitously or for a small compensation, a regulation also applying to the perusal of the newspapers, periodicals, and annual reports in their possession, being fifty-one in number. Of these, four are published by the government, forty-one by the societies, and six by private persons. The objects to which these publications are individually devoted are as follows: Horticulture, five; breeding, rearing, and management of horses, four; fruit-culture, one; forest-culture, one; wine-culture, one; bee-cultrre, three; silk-culture, two; statistics, two; the rest being devoted to agriculture generally. The agricultural publications in other parts of Germany, so far as is ascertained, amount to thirty-eight; the whole number being eighty-nine.

Of agricultural institutions for education there are two classes—one including the colleges, and the other the elementary schools. Of colleges, there are five, three of which are supported by the government, but two are private. In the colleges are taught the various systems of husbandry, farm management, book-keeping, cultivation of arable and grass-lands, horticulture, landscape gardening and rural embellishments, silviculture, agricultural technology, mechanics, natural philosophy, botany, mineralogy, a knowledge of the soils, mathematics, agricultural chemistry, zoology, breeding, rearing, and management of animals, veterinary surgery, classification of sheep and wool, entomology, practical operations in the garden and field, designing and drawing, national economy, and the law and history appertaining to agriculture.

There are twenty-eight elementary schools, some of which are supported by the government; others by societies; while a third class is private. In these are taught the elementary branches of agricultural education, by lectures and demonstrations, in a manner adapted to the comprehension of the pupils.

Besides the above, there are other schools devoted to special objects: Draining and improving meadows, five; management of forests, ten; horticulture, six; silk-culture, one; flax-culture, four; bee-culture, one; raising of sheep, two; spinning schools, fifteen; the whole number being fifty-seven. In the neighborhood of some of these schools, there are machine shops, where the pupils have an opportunity of witnessing the making of various machines, thus uniting practice with theory. There are also model farms and experimental grounds of various sizes, amounting in all to seventy-two,

some being conducted by the government; others by societies; while a third class belongs to private individuals. Instruction is often encouraged by premiums offered by societies to the best pupils. The more important of these institutions have commissioners appointed to furnish regular reports to the Department of Agriculture, and though the greater number of them have only been in existence for about ten years, the results are considered satisfactory.

For the further improvement of flax-culture, the government provides some districts with stationary, and others with itinerant teachers, practically trained for the cultivation of flax and dye plants. There is also set aside for this purpose a special appropriation (the Royal Grace Fund) and a mutual stock company. In its manufacture penitentiary labor is sometimes employed. Some of the societies provide for the distribution of good flax-seed and machinery, publishing, also, circulars on its improvement.

For silk-culture, there are ten reeling establishments, and twenty-one mulberry plantations. Some of the societies distribute cuttings and seeds, a portion of which is planted on roadsides, graveyards, and other public places. Among the silk-growers there are some who also give instruction in this branch, as is done in the model silk establishment at Breslau, which has reeling and spinning machines, with an operative hatching machine, and eighteen smaller ones, the latter distributed as models among the agricultural officers in the various parts of the districts. It has also three ingenious models for showing the interior structures made by the worms in the stages of the last development. It likewise issues communications on this subject.

The improvement of arable and grass-lands is liberally and most advantageously encouraged and promoted on the part of the government and societies by judicious appointments of draining engineers in several parts of the country, the profits of which enterprises, in an agricultural and economical point of view, are most clearly shown in the construction of excellent roads as well as in those large tracts of arable and grass-lands regained from a net of lakes and swamps in the northeastern part of the kingdom.

With regard to fruit-culture, there are several model pomological gardens, a large number of nurseries for growing fruit-trees, coniferous and foliaceous trees, and two for raising tree seeds. Some of these nurseries are conducted by the government; others by the agricultural societies, with a view of distributing seeds, cuttings, and trees among their members, an illustration of which is given in an official report on the nurseries planted in the province of Westphalia in 1855. From this report, it appears that this province has nine hundred and forty-five nurseries, containing four hundred and thirty-nine thousand, four hundred and eighty ungrafted stocks, and two hundred and twenty thousand, one hundred and sixty-two grafted ones, and that the trees sold and distributed over the province amounted to twenty-three thousand, one hundred and forty-one. Some of the nurseries are the property or in charge of private persons, especially of experienced teachers, for the purpose of diffusing that kind of

knowledge, and encouraging their pupils to plant nurseries of their own, as in many cases has been satisfactorily done. In other parts of Germany, the community and schools of every village are supplied with suitable nurseries, placed under the charge of the teachers.

In respect to the improvement of horses, it may be remarked that, in addition to the public studs, the societies hold annual shows, establish horse markets, depôts for stallions, in several districts, keep well regulated and extensive pastures for colts, and also have race courses. The Society of Berlin, for the improvement of horses, publishes an annual report, a "Coursing Almanac," and the general Stud Book, containing the pedigrees of all the full-blood horses in Germany.

In addition to the societies before mentioned, it may be stated that there is also the Itinerant Society of German Agriculturists and Foresters, including not only members of Prussia, but those of all other German States. This society, now in the twentieth year of its existence, bears the character of a National Congress, which investigates and discusses all subjects having a general scientific and practical tendency to the improvement of agriculture. At various points they have stations for experiments in agricultural chemistry, physiology, &c., for the purpose of settling important questions proposed at their annual meetings, which are held alternately in the principal cities of the confederation.

ENCOURAGEMENT OF AGRICULTURE IN THE UNITED STATES.

In tracing the progress of agriculture in the United States, let us revert to the condition of the country when first visited by Europeans. Then, this art was only practised by the wives of the Indians, in limited areas of tobacco, beans, pumpkins, and maize, without the aid of domestic animals, or any implements, except clam-shells, the scapula of the buffalo, the antlers or horns of the deer and elk, and pointed sticks of wood. At this period, a large portion of the soil of our territory was charged with an abundance of humus and earthy phosphates, the accumulations of ages, from the decay of primitive forests, other vegetation, or of animal remains; and it is a question worthy the attention of agriculturists and political economists, whether there was not absolutely more wealth invested in our soil, in fertilizing matter, at the time Columbus discovered America, than there is at present above the surface in improvements and investments of every kind. European settlements began, and civilization gradually extended, heralded by the sound of the woodman's axe and the crash of trees. As the country became more and more settled, considerable tracts, situated in what now constitute the Atlantic and Gulf States, were cleared, laid open to the sun, and converted into luxuriant meadows and fertile fields of tobacco, cotton, sugar-cane, and the Cereal grains. Meanwhile, most of the soluble phosphates and other elements of fertility, which originally existed in the soil, were exhausted by injudicious cropping, or from neglecting to return

to the land an equivalent in manure for what had been abstracted by the plants. The result has been, instead of full and abundant crops, the older cultivated fields do not yield at present half as much as formerly, and in many localities, not a third, nor even a quarter as much, without the application of extra supplies of manure. To carry the evil still further, many of the farmers and planters of the present day, along the Atlantic seaboard and on the Mexican Gulf, are still exhausting the fertilizing matter of their lands by adding thereto large quantities of Peruvian guano, or other concentrated manures, which, when their immediate effects are over, will generally leave the soil in a poorer condition than it was in before they were applied. A similar devastating course, it is to be regretted, is now being pursued by many of the agriculturists of the States west of the Appalachians ; and unless this improvident practice be checked, and due regard be paid to stock-raising—the very foundation of successful farming—and a judicious rotation of crops be observed, the result will inevitably be the same as it has been in the older-settled States.

From entering at length and minutely into the rise and progress of agriculture in this country, we are prevented as much by the want of the necessary information, as by the immediate object and limited length of this paper. As all inquiries on this subject must be derived from facts, they can only be answered by history or statistics, which throw comparatively but little light on these topics up to the period of the formation of our government. It appears, however, that it was the wise and far-sighted policy of all the civilized nations who laid claim to American soil, except in some cases, where an insatiable avarice prevailed in subjecting the Indians to involuntary servitude, or otherwise depriving them of their natural rights, to encourage the agriculture of their respective territories by inducing emigration, in making free grants or concessions of land to companies, as well as to individuals ; in conceding to them the exclusive possession and enjoyment thereof, by pre-emption, or by the payment of a nominal sum for such quantities as they might choose to hold ; and in fostering particular branches of rural industry by awarding premiums or bounties for agricultural improvements or increased productions.

Thus, in 1495, shortly after the brilliant discoveries of Columbus, Spain, "in order the better to facilitate the emigration and permanent establishment of colonists, offered to all who wished to go, provisions for a year ; to defray the transportation of their supplies and persons ; exemption from all duties and imposts ; and the perpetual ownership of the houses they might construct, and the lands they might cultivate."

In 1523, among other regulations for the benefit of New Spain, it was ordained that, since it was a land newly discovered, and not peopled by Christians, there should be given to the first colonists, by way of reward and extra satisfaction for their labors, two knights' allotments of land to each, in the cities and towns which they might prefer, in order to build ; and that they should be permitted to sell them and do with them as things belonging to themselves.

In 1565, Spain granted to Francisco de Eraso 25 leagues square, (3,600,000 acres,) to be located wherever he pleased, in Florida, with the office of governor, and various other titles and privileges for himself and heirs, exempting them from imposts and duties, on conditions that he should provide several caravals for exploration, and colonize his tract, within three years, with 500 settlers, most of whom should be husbandmen, 500 slaves, 100 horses and mares, 200 heifers, 400 swine, and 400 ewes.

In 1622, the "London Company," in Virginia, was encouraged by James I. in the breeding of silkworms and the establishment of silk works. In about the year 1651, this branch of industry again became an object of interest in that colony, and premiums were offered for its promotion.

In 1657, the growth of hops was encouraged in Virginia by legislative enactments.

In 1717, a royal grant of 144 square miles was made by France to the celebrated John Law, on the Arkansas, with a complete monopoly of the trade and mines of the Territory for twenty-seven years, on condition of introducing from Germany or Provence 1,500 persons to settle the land.

In 1732, a parcel of ground belonging to government was allotted as a nursery plantation for mulberry-trees in the infant settlement of Georgia, and several of the colonists were soon after engaged in rearing silkworms.

For ten years preceding 1743, the British Parliament granted to the patentees of Georgia $600,000 (£120,000) for the encouragement of the culture of indigo and other agricultural crops.

In 1749, an act of Parliament was passed for encouraging the growth of silk in Carolina and Georgia, exempting the producers from the payment of duties on importation into London.

In 1766, the house of assembly of the province of Carolina voted the sum of $5,000 (£1,000) towards the establishment of a silk filature at Charleston.

In 1768, the Society for Promoting Arts, &c., at New York, awarded a premium of $50 (£10) to Thomas Young, of Oyster bay, for the largest nursery of apple-trees, the number being 27,123.

In 1783, the legislature of Connecticut passed an act granting a bounty on the production of mulberry-trees and the rearing of raw silkworms.

In 1785, by an arrangement between the courts of France and Spain, a large number of Acadian families (about 2,500 persons) were transferred to Louisiana at the expense of the French King, and joined the colonists from Malaga and the Canaries, imported a few years before at the expense of Spain.

In 1786, an ordinance was given at Madrid, under the Spanish ministry, commanding that the colonial authorities should, "by all possible means, * * * * * extend agriculture and the sowing of grain, especially that of wheat, by assistance of the exemption from royal duties, enjoyed by flour exported from Vera Cruz and other ports of that kingdom."

In 1787, Diego de Gardoqui, minister from Spain to the United States, formed a plan for encouraging emigration from Kentucky and North Carolina to the Arkansas. He obtained from a Mr. Morgan the grant of a large tract, on which he laid the foundation of a city, dignified with the name of "New Madrid"—afterwards the post so-called. Morgan, it is stated, made many sub-concessions to his settlers.

In 1795, Señor Marquis de Maison Rouge, an eminent French knight, conceived the idea of forming a colony in the prairie Chatelleran, on the river Ouachita, in Louisiana, which, at that time, belonged to the Spanish crown, principally with the object of cultivating wheat and erecting mills for the manufacture of flour. The inducements then offered by the laws and government of Spain to such undertakings were very great. As it was the policy of that country, like our own at present, to encourage the population of her vast and magnificent realms, which lay almost valueless, until their resources could be developed under the influences of immigration and civilization, a grant was made to the marquis, on the 14th of July, of 30 superficial leagues, provided he should cause to be brought into the province, from the United States, thirty families of immigrants, which were to descend the Ohio. Baron de Carondelet, then military and civil governor of Louisiana, agreed to pay out of the royal treasury $200 to each family of two white persons fitted for agriculture or for the arts useful and necessary for the establishment; and $400 in addition to each family having four useful laborers or artificers, or $100 each for a less number. He also agreed to assist each family from New Madrid to Ouachita, with a skillful guide, and provisions sufficient for their support until they should reach the place of destination, allowing them each 3,000 pounds of baggage, implements, &c., to be transported by sea to New Orleans, and thence to Ouachita. Each of said families was to receive 400 square arpents of land, which was to be increased in proportion to the number of white cultivators it might possess. No Americans were to be admitted on the lands included within this grant. The marquis introduced the full number of settlers required, and the conditions of his contract as a *poblador* were fulfilled.

In 1796, Philip Henry Neri de Tot Bastrop, a nobleman of Holland, residing in Louisiana, conceived a similar idea to that of the Marquis de Maison Rouge, the year before, of forming an extensive colony in that province for the same purpose, of which he was to be the chief. A grant accordingly was made to him by Spain on the 21st of June, 1796, of 12 leagues square, one half situated on the side of Bayou de Siar, and the other on the side opposite the Ouachita, with the exclusive enjoyment of 6 toises of land on each side of said bayou from its source to its mouth, in order that he might construct the works and embankments requisite for mills. He was permitted to export to the Havana and other places, free, the commerce of the province, without restriction. The government also was to charge itself with the transportation of families from New Madrid to Ouachita, and furnish them with seed for sowing, and provisions sufficient for their main-

tenance during six months. It appears that, upon reconnaissance, a change in the location was advisable, in consequence of portions of the tract being subject to inundation, or occupied by the ancient inhabitants; and a new grant was issued the following June, giving the same quantity of land, to be taken upon the river Ouachita and the Bayou de Siar and Barthelemi. In return, Baron de Bastrop, in the capacity of a colonizer, was bound to introduce settlers to a number exceeding two hundred and fifty families, to each of which he was to assign a tract of land of not more than 400 square arpents. These requisitions were complied with on the part of De Bastrop, as far as he was permitted; many families were introduced and measures taken to erect a mill, and to make other improvements; but he was prohibited by the local government from carrying out his designs, as it neglected to transport the settlers and to furnish them with provisions and seeds. Consequently, De Bastrop was not allowed to fulfil his obligations, being compelled to abandon the enterprise forever, as Spain, on the 30th of April, 1803, transferred to the United States, through France, by a secret treaty of 1800, the magnificent province of Louisiana, which then stretched from the great lakes of the North to the waters of the Mexican Gulf.

On the 9th of August, 1796, another grant of 458,963 acres (536,904 arpents) was also made by the Spanish government to James Clamorgan, a merchant then residing at St. Louis, with the object of establishing a rope manufactory to supply his Majesty's navy and the Havana with cordage; procuring farmers from Canada to engage in the cultivation of hemp; and to give instructions in its manufacture. This grant called for the tract of land now lying partly within the boundaries of Missouri and partly in Arkansas, on the western bank of the Mississippi, beginning at the place which is opposite the head of an island situated about 100 arpents below the Little Prairie, about 30 miles below the village of New Madrid. The continuance of hostilities between Spain and England prevented Clamorgan from obtaining his farmers from Canada, and from commencing the culture of hemp, until Louisiana was transferred to the United States in 1803.

On the 3d of March, 1817, Congress granted four townships of unoccupied land (92,160 acres) lying in that part of the Mississippi Territory now comprised within the counties of Greene and Marengo, in the State of Alabama, to Charles Villar, agent of an association of emigrants from France, for the purpose and on the conditions of settlement of at least one adult to each half section contained in the said four townships, and for the cultivation of the vine, the olive, and other vegetable productions, no settler being entitled to more than 640 acres; the grantee to pay the government of the United States the sum of $184,320 ($2 per acre) on or before the expiration of fourteen years. It was further stipulated that, within three years from the date of the contract, there should be made upon each tract allotted to the respective associates a settlement by themselves, individually, or by others on their account; that, on or before the expiration of seven years, there should be cultivated at least one acre of each quarter section, taken aggregately, in vines; and that there

should be planted within that period in said four townships not less than five hundred olive-trees, unless it should have previously been established that the olive could not be successfully cultivated thereon.

It appears from the Report of the Secretary of the Treasury, in December, 1827, that there were 7,414 acres cultivated within the above-named tract, principally in vines, cotton, corn, small grain, &c. The quantity of land devoted to the vines was $271\frac{1}{2}$ acres, which, according to an estimate, is not more than one-tenth part of what was originally planted. The vineyards occupied fields which had previously been cultivated with cotton, the vines standing 10 feet apart in one direction and 20 feet in the other, each fastened to a stake. The number of olive-trees standing on the grant was three hundred and eighty-eight, some of which were six years planted and others only three. There were also planted on the tract twenty-five thousand olive seeds. It has been stated that about five hundred French emigrants settled under this concession, yet, comparatively but few made any considerable improvements, although extensive and profitable farms were in possession of Americans who had purchased them from the grantees. The chief reasons assigned for the failure of performance on the part of the emigrants were not only the natural obstacles incident to the settlement of a new country, but many of them came prematurely to their lands without funds sufficient to improve their allotments or even to provide for their immediate support. The region of country to which they were to remove was then a wilderness, almost impervious to the approach of man, and the means of transportation were so difficult and expensive, that many persons, upon their arrival, were compelled to settle temporarily on small lots of land, where their funds were exhausted, and they became unable to make a second settlement on a larger scale. For several years, the colony was remarkably unhealthy, scarcely a family escaping sickness, and numbers of the grantees died. Again, possessing, as they did, but little knowledge of our agricultural economy, strangers to the language, the manners and habits of our people, it is not surprising that they should be retarded in their progress, and be less prosperous than the citizens of the United States.

The chief causes which led to failures in the culture of the olive and the vine were ascribed to the necessity each grantee was under of first obtaining the means of subsistence; the difficulty and length of time required in clearing and preparing the land—nearly seven years elapsing before this was accomplished; yet, very early importations of cuttings were made, a large quantity of which arrived out of season; and when we consider the lateness of the period in Europe at which they had to be taken, and the early time at which they must be planted in Alabama, it is obvious that any considerable delay in the arrival of vessels must have caused them to perish on the way. All of the cuttings which arrived alive were carefully planted, though large numbers of them died, owing, as was believed, to the newness of the soil. Again, the kinds of vine imported did not appear in all cases to be adapted to our climate, and, doubtless, the modes of culture in Europe and in this country are radically different. Finally,

the olive-trees that were planted perished with every winter's frost, but put up fresh shoots again in the spring, which also perished with that of the succeeding season.

On the 30th of June, 1834, Congress granted 36 sections of land (23,040 acres) to the Polish exiles, then recently expelled from Europe by Austria, on conditions of actual settlement and the improvement of the soil.

In 1838, similar views again, probably, prompted Congress to grant to Dr. Henry Perrine, a township 6 miles square (23,040 acres,) in Dade county, in Florida, on the implied condition of introducing the culture and "domestication" of tropical plants. But, perhaps, owing to the want of a practical knowledge of the business and of funds adequate to carry the project into execution, little, if anything, was done by Dr. Perrine, and the enterprise was abandoned at his death, in 1839.

The pre-emption system afterwards expanded into one of vast proportions, under the passage of the act of Congress of the 3d of March, 1799, which was special, and only included certain purchasers of lands in the Northwest Territory, under one John Cleve Symmes, being more in the nature of a relief act. At various periods since that time, extending through a space of about thirty years, special pre-emption acts were passed for the benefit of settlers in Mississippi, Tennessee, Ohio, Michigan, Florida, Alabama, and Arkansas. But the first general pre-emption law was approved May 29, 1830. This act gave to every settler or occupant of the public lands, prior to its passage, and then in possession, and who had cultivated any part thereof, in the year 1829, the right to purchase his claim, not exceeding a quarter section, or 160 acres, in preference to all other persons, upon performing the conditions of the act, at the government minimum price of $1 25 per acre, and by its own limitation was to continue in force for a year from the date of its approval. Afterwards, several acts were passed, continuing the privileges of the above act to certain settlers. On the 22d June, 1838, the privileges of the act of 1830 were extended to every settler, who was the head of a family, or over the age of twenty-one years, in possession as a housekeeper by personal residence, on the land claimed at the time of its passage and for four months preceding.

The next in order of time is the act of June 1, 1840, which was supplemental to the act of 1838, and enlarged the privileges therein granted. But the great pre-emption act, which has superseded all prior laws on the subject, and which has disseminated its blessings throughout the extent of our great country, was approved the 4th September, 1841, and its provisions in the main have governed in all subsequent enactments up to the present time. Our legislators, at that period, seem to have been actuated by a noble spirit of liberality both to aliens and to natives, not forgetting the rights of women. This act has probably done more towards the promotion of settlements in the vast regions of the West and Northwest, and in the development of their agricultural resources and interests, than all other causes combined. It gives to every-one who is the head of a family whether

a widow, or any man over the age of 21 years, and being a citizen of the United States, or having filed his declaration of intention to become a citizen, as required by the naturalization laws, who had made or should make a settlement in person on any public lands to which the Indian title had been or should be extinguished at the date of settlement, said lands having been surveyed, who shall inhabit and improve the same, and erect a dwelling thereon, the right to enter any number of acres, not exceeding 160 in one body, to include the residence of such settler, upon paying to the United States the minimum price of such land. The right is restricted, however, to such as did not own 320 acres of land at the time of settlement, and no one is allowed to enjoy it who shall abandon a residence on his own land to settle upon the public land in the same State or Territory, and the right can only be enjoyed once under this act. The blessings of this law to individuals and families, and its advantages to the government itself, are inestimable. Thousands upon thousands of indigent families have thus been enabled to obtain comfortable homes, and, by means of their settlements, our western wilds have been subdued into civilization, and covered by the farms of a prosperous and happy people.

In 1844, an act was passed for the relief of citizens of towns under certain circumstances, which gives the right to enter by pre-emption 320 acres of land, so settled and occupied as a town site, in trust for the several use and benefit of the inhabitants, according to their respective interests.

By the act of the 3d of March, 1855, contractors carrying the mails through the Territories west of the Mississippi are authorized to pre-empt their stations, not more than one for every 20 miles of the route, to the extent of 640 acres at each station. In 1853–'54, the pre-emption law of 1841 was extended to the public lands in California, Kansas, Nebraska, Minnesota, Oregon, Washington, and New Mexico, and the right of settlement was conferred upon unsurveyed as well as surveyed lands. This privilege of settling upon unsurveyed lands has been of great advantage to the hardy pioneers, and has done much towards the peopling of our vast territorial possessions.

In Oregon and Washington, stronger inducements were offered by the donation acts, which grant to settlers upon the public lands in those Territories, under certain conditions and restrictions, a half section of land to a single, and a whole section to a married man. In the latter case, one-half is secured to and vests in the wife, another very wise and beneficent interposition in favor of females.

This is but a cursory view of our pre-emption and donation systems, and the laws upon which they are based; all having in view the expansion of our country, as well as the happiness, advancement, and prosperity of the great masses of our people.

Towards the close of the last century, a new era dawned upon the productive industry of both hemispheres, in the formation of agricultural associations and economical societies, the beneficial effects of which were manifest from the interest they elicited on the part of

the more intelligent class of farmers, as well as that of the merchants and political economists of the day.

The first association of this kind formed in the United States, so far as is known, was "The Philadelphia Society for Promoting Agriculture," established on the 1st of March, 1785, by a body of citizens, only a few of whom were actually engaged in husbandry, but who were convinced of the necessity and of the assistance which an association, properly managed, would afford to the interests of agriculture. This society continued to meet regularly for several years, and published numerous valuable communications from practical men in the newspapers of the day, thereby contributing to diffuse the knowledge of many improvements in rural affairs, the general adoption of which visibly tended to augment the fertility and to increase the products of the soil of Pennsylvania. Premiums were proposed and conferred for the elucidation of subjects upon which information was desired, and for the adoption of approved systems and modes of European culture, as well as for the improvement of certain articles of domestic manufacture. Among the latter, for instance, may be mentioned cheese, for the best sample and greatest quantity of which a gold medal was awarded to Mr. Mathewson, of Rhode Island, in 1790.

After several years of active exertions, this society was unfortunately permitted to slumber until the winter of 1804, when it was revived under the laudable and patriotic efforts of the late Judge Peters, through whose indefatigable exertions regular meetings were resumed, new subjects for premiums proposed, and numerous communications received, which were published in the Memoirs in 1808–'11, and afterwards. The society was incorporated by the legislature of Pennsylvania on the 14th of February, 1809.

The first agricultural association incorporated in this country was the "Society for the Promotion of Agriculture," established in South Carolina, in 1785, the objects of which were to institute a farm for experiments, to import and distribute foreign productions suited to the climate of Charleston, and to direct the attention of the farmers and planters of the State to economical purposes, as well as to reward those persons who should improve the art of husbandry. Among other subjects of interest which received the attention of this society were some cuttings of the olive and of the vine. The former succeeded very well; but the climate near Charleston proved too moist for the perfection of the grape.

In 1791, a few patriotic citizens founded in the city of New York a "Society for the Advancement of Agriculture, Arts, and Manufactures." This association was in operation only about 10 years, having ceased at the close of its incorporation.

Next in chronological order stands the "Massachusetts Society for Promoting Agriculture," which was incorporated on March 7, 1792. The design of this institution was to promote useful improvements in agriculture, and the association was empowered by law to hold, purchase, and receive in fee simple, or any less estate, by gift, grant, devise, or otherwise, any lands, tenements, or other estate, real and

personal; provided that the annual income of the said real and personal estate did not exceed the sum of £10,000; and also to sell, alien, devise, or dispose of the same estate, real and personal, not using the same in trade or commerce.

No society in the Union, perhaps, has contributed so much to promote its object as the one under consideration. The trustees, by prudent care and good management, have not only ever had a surplus of funds in their treasury, obtained through donations from generous and public-spirited gentlemen and by annual assessments on the members, but they have exerted its beneficial effects by holding public exhibitions and offering rewards for the encouragement of agriculture and the arts, the results of which have been made known to the world through its journals. A considerable portion of the moneys accumulated has been expended in importing improved breeds of domestic animals for the free use of the State; agricultural implements and machinery of approved construction, to serve as models from which others might be manufactured; the standard works on European agriculture; and in sending agents abroad for acquiring agricultural information on such topics as might prove useful at home. The attention of the trustees has long been directed to the important and disputed question, how far and in what way the primitive breeds of cattle of New England may be improved by the admixture of foreign races, and more particularly, which of these races, from its valuable qualities for work or for the dairy, as well as its capacity of thriving in that climate, and under the degree of care and protection which can be conveniently given to it by the farmers, would best repay the expenses and trouble necessarily incident to its first introduction. These motives, as is well known, led the society, some 12 years ago, to purchase and import several fine animals of the North Devons and Ayrshires, which were placed in charge of a responsible person for breeding. As soon as this stock was sufficiently multiplied, pairs of one or the other of these breeds were distributed to each of the county societies of that State, for further experiment. Subsequently, another importation was made of the Jersey or Alderney breed, for similar purposes as above.

In December, 1793, a circular was issued by several members of this society, residing in the county of Middlesex, inviting other members to lend their aid in taking such measures as would appear calculated to promote and, in general, to improve the husbandry of that county. On the 27th of October, in the year following, a new society was fully organized, appointing committees to receive communications upon agricultural subjects, to hold meetings, &c., the latter of which were afterwards held three times a year. In 1804, this society was duly incorporated by the legislature, and, so far as known, was the first county agricultural association formed in the United States.

On the 12th of March, 1798, the legislature of New York passed an act establishing a "Society for the Promotion of Agriculture, Manufactures and Arts;" and on the 2d of April, 1804, another, entitled "An act to incorporate a Society for the Promotion of Useful

Arts," in which agriculture is first named. This society published seven volumes of its Transactions prior to 1815.

In about the year 1800, the Kennebeck Agricultural Society was formed in the District of Maine, and was continued with considerable activity for a period of several years. A number of interesting papers, emanating from this society, were published in the Repository and Journal, issued by the Massachusetts Society for Promoting Agriculture, in 1803.

In August, 1810, Mr. Elkanah Watson, of Berkshire, in Massachusetts, wrote an appeal to the public, which he induced twenty-six farmers to sign, appointing a cattle show at Pittsfield, on the 1st of October of that year, which took place, and it is believed, was the first agricultural fair ever held in America. The Berkshire Agricultural Society was incorporated in the winter of 1810–'11.

From this era sprang the system of agricultural societies and shows, as they exist at present, in most parts of the United States. Through the perseverance and patriotic efforts of Mr. Watson, the gentleman mentioned above, societies were formed, not only in many of the counties of New England, but in New York, Pennsylvania, Delaware, Maryland, Virginia, North Carolina, South Carolina, Ohio, Kentucky, and Tennessee, as well as boards of agriculture in several of these States.

In 1819, the legislature of New York appropriated $20,000, to be divided in two years, for the promotion of agriculture and family domestic manufactures, to be equitably distributed among the agricultural societies of the counties of that State. By the same act, the sum of $1,000 was also appropriated for the purchase of useful seeds, to be distributed to said societies for experiment, and a board of agriculture was established, to be comprised of the presidents of these societies, who were authorized to compile and publish fifteen hundred copies of a volume of archives at the expense of the State.

In 1828, the "American Institute of the city of New York" was incorporated for the broad purpose of encouraging and promoting domestic industry throughout the United States, by bestowing rewards and other benefits on those who excel in any of the departments of agriculture, commerce, manufactures, and the arts; serving also as the agricultural society of the county of New York. The officers, committees, and clubs of this institution have ever been active in promoting the objects of its formation. The annual volumes of Transactions, published with commendable liberality by the State, not only contain reports of the progress of the institute itself, but those of the judges of the fairs, as well as the addresses and useful papers on subjects coming within the wide scope of its design.

In 1832, "The New York State Agricultural Society" was incorporated to continue for the term of 20 years, with power to take and hold real and personal property; but lest the farmers should combine and turn speculators, they, with commendable caution provided that their real estate should not exceed $25,000. This charter was renewed in 1852, restricting their personal property to $10,000. Notwithstanding the spirited exertions of many gentlemen in different

parts of the State, not much was effected by the society for the eight or nine years after its first incorporation. But after the importation of bread-stuffs, to the amount of several millions of dollars, in 1837–'38, made necessary to a considerable extent from a neglected cultivation, and after many other evidences of a decaying agriculture, an energetic effort was made by many of the most active men of the State, as well agriculturists as others, to reanimate the society, and through its agency, if possible, to awaken a spirit of improvement with the farming classes.

On the 5th of May, 1841, the act for the encouragement of agriculture was passed by the legislature of New York, appropriating $8,000 for five years, to be divided among the agricultural societies, which has been continued to the present time. The State Agricultural Society was recognized the same year, and a cattle show and fair held at Syracuse, which was a most creditable one, exceeding the expectations even of the most ardent friends of the cause. These fairs have been continued, increasing in interest, utility, and importance, every year.

Since the formation of the society last named, "State Agricultural Societies" have also been incorporated in Alabama, California, Connecticut, Georgia, Illinois, Iowa, Kentucky, Maine, Maryland, Michigan, Minnesota, Mississippi, New Hampshire, New Jersey, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, and Wisconsin; "Boards of Agriculture" in Indiana, Massachusetts, Ohio, and Tennessee, and numerous "County Agricultural Societies," and other associations in which agriculture and horticulture are encouraged, have been formed, making in the aggregate about eight hundred in number in the States and Territories. The operations of all these associations, in detail, would form a subject for an essay in a future Report.

Another interesting feature in our industrial history is the annual appropriations by Congress for the collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement of cuttings and seeds for gratuitous distribution among the farmers, which appropriations are expended under the direction of the Patent Office; the idea having originated with Hon. Henry L. Ellsworth, in 1839. The sums appropriated each year, since that period, for the above-named objects, and the number of copies printed of the Agricultural Reports, with the size of each volume, are denoted in the following table:—

Appropriations for agricultural statistics, &c.

YEARS.	Appropriations.	Copies of reports printed.	Pages in each volume.	Remarks.
1839	$1,000	--------------	54	Agricultural and Mechanical Reports combined.
1840	None.	--------------	60	Do.
1841	None.	--------------	84	Do.
1842	1,000	--------------	174	Do.
1843	2,000	--------------	522	Do.
1844	2,000	--------------	710	Do.
1845	3,000	--------------	1,376	Do.
1846	None.	--------------	366	Do.
1847	3,000	--------------	1,004	Do.
1848	3,500	--------------	1,142	Do.
1849	3,500	--------------	574	Agricultural (alone.)
1850	4,500	--------------	580	Do.
1851	5,500	145,420	676	Do.
1852	5,000	145,420	448	Do.
1853	5,000	152,920	448	Do.
1854	35,000	167,920	560	Do.
1855	25,000	267,920	550	Do.
1856	105,000	267,950	552	Do.
1857	63,500	242,950	552	Do.
1858	60,000	--------------	--------------	

The results of these appropriations may be judged of in a measure on the perusal of the Reports of this Office.

Another object of encouragement from the public purse, and one which was advocated by Washington and Jefferson, as well as by other Presidents since, is agricultural education. No direct aid, however, has thus far been bestowed upon it by the general government, nor until a comparatively recent period by any of the States.

The first important movement in this matter was made by the late Judge Buel, of Albany, in 1838, who endeavored to establish an agricultural college, connected with an experimental farm, to be endowed by the State for the education of farmers' sons. The same object was urged upon the legislature by the American Institute of New York, in 1844, and the project was again revived by the executive committee of the New York State Agricultural Society, in 1849. The latter, failing in their exertions, concluded to suspend their efforts, "and wait what change the wheel of time might bring." In 1853, the late John Delafield, of Seneca county, procured the passage of an act by the legislature to incorporate the "New York State Agricultural College," providing no pecuniary aid from the State, but leaving the trustees to commence the work from private contributions. Considerable progress had been made in obtaining subscriptions to the fund, but, on the death of Mr. Delafield, the matter was again suspended. In the year 1855, the citizens of Ovid, in the county of Seneca, and in its vicinity, with a most commendable spirit, made an active effort to carry the project into execution. A subscription was

opened and another act passed by the legislature providing pecuniary means for the establishment of an institution, which it is confidently believed will succeed. The act provides for loaning from the surplus of the United States Deposit Fund $40,000 for twenty-one years, without interest, to be expended in the purchase of a farm, in Seneca county, of not less than 300 acres, and for the erection of college buildings thereon, provided the like sum of $40,000 should be obtained by private subscription for the same purpose, and its payment secured to the satisfaction of the comptroller, and the land so purchased to be mortgaged to the State to secure the payment of the money loaned. The trustees accordingly selected a farm of 680 acres lying between the village of Ovid and the easterly shore of Seneca Lake. Possession has been taken of this farm and the college buildings are in process of erection.

A kindred institution was also chartered, in 1854, by the legislature, under the name of "The People's College of the State of New York," which is located at Havana, Schuyler county. The design of this institution is to give instruction in agriculture and the mechanic arts, and such other branches of knowledge as the students may prefer. Connected with it is a farm of 200 acres, on which the college buildings are now being erected.

The State of Michigan has a constitutional provision requiring her legislature to establish an agricultural college; conformably to which an appropriation of $50,000 was made, in 1855, with which a tract of nearly 700 acres was purchased in Lansing, and the buildings erected. In 1857, the legislature made a further appropriation of $40,000 for the use of this establishment; and in the May following, the first class of students was received. The design of this institution is to receive the pupil direct from the common schools of the State, and give such a course of English and scientific education as will render him an intelligent citizen and a practical farmer, qualifying him to discharge such duties as his country may require.

In March, 1855, "The Farmers' High School of Pennsylvania" was incorporated, at the instance and under the auspices of the Pennsylvania State Agricultural Society, for similar objects as those of the Agricultural College of Michigan. It is located at the junction of Nittany and Penn Valleys, near Bellefonte, in Centre county, and comprises, with the buildings now being erected, a farm of 400 acres, 200 of which were donated by General James Irvin, of Bellefonte. Its resources consist of $10,000 appropriated by the State Agricultural Society; a legacy of $5,000 from the late Elliott Cresson, of Philadelphia; $10,000 subscribed by the citizens of Centre county; and an appropriation of $50,000 by the legislature, one half of which was made contingent upon a similar amount to be obtained from other sources, forming an aggregate capital of $100,000. The trustees have erected several of the requisite buildings, among which is the school edifice that will accommodate, when completed, three hundred students. The farm, at present, is under the supervision of Mr. William G. Waring, who has for some time been engaged in planting orchards and hedges, as well as in embellishing the grounds with shade trees

and evergreens, and in making preparations for a model farm. As it is designed that this school shall, in a manner, sustain itself by the industry of the pupils, only a comparatively small tuition fee will be charged. It is expected that it will be open for instruction the present year.

In the winter of 1856, the legislature of Maryland passed an act appropriating $6,000 per annum for the perpetual support of an agricultural college, on condition that $50,000 should be raised by private subscription for its establishment. It may here be stated that the trustees were greatly encouraged and stimulated to increased exertion to raise the required amount by subscription, to entitle them to the endowment from the State, by a munificent donation, voluntarily made, by Dr. William Newton Mercer, a native of Maryland, but now a citizen of Louisiana. The homestead of Mr. Charles B. Calvert, situated near Bladensburg, in Prince George's county, nine miles northeast of Washington, comprising 428 acres, has recently been purchased; plans and specifications are in preparation for the buildings, and arrangements are being made to procure materials for their erection. The soil of this farm varies in quality and condition, affording a fair opportunity for experiment. It consists chiefly of rich meadows, artificially drained, dry bottom-lands, undulating pastures and moderate hills, abounding in wood, and irrigated by a rapid stream of pure water, sufficiently copious to afford any motive power or other useful purpose the establishment may require. The site of the proposed college buildings is a commanding eminence, so fully exposed to constant ventilation as must entirely exempt it from miasmatic influence, which, it is believed, will render the locality permanently healthful.

The ultimate end aimed at by the trustees is the foundation of an "Educational Institution" in its most comprehensive sense. Its definition of education is, that it is the united symmetrical development and instruction of the religious, the intellectual, and the physical qualities of the man. It recognizes the whole man in all the departments of his being as the object of its care. Its aim is not merely to instruct, nor to impart knowledge, but to awaken, develop, train, and discipline all the talent, inborn powers, and faculties of man, that he may command them for the high and noble uses of which they may be capable, or for which they were designed. It claims for the farmer or the mechanic, or for whomsoever its care may be sought, first, his development as a man, trained and fitted to the full extent of his capacity, for all the duties of a good citizen. To this end, it offers him the advantage of the most approved system of moral and intellectual culture; and superadds to these, for his physical training, moderate and systematic exercises in the field and the workshop, as the best means of laying the foundation of future health and energy, in a well developed, robust, physical constitution. Thus, incidentally, if not primarily, the scheme embraces the best practical training in agriculture and mechanic arts. The student will acquire skill and handicraft in the use of tools and implements, from the hammer or the hoe to the scythe or the plough; he will learn the construction and management

of all such machinery as he may probably have the future use of. These exercises are to be learned simultaneously with his scientific instruction, in the lecture room, and the valuable mental habit will be acquired of referring the daily operations to their principles, and of watching and noting the facts and circumstances, which, in practice, will modify the application of purely scientific theories. The well informed mind and the cunning right hand will learn to work together, and labor will be enlightened and dignified by its association with science.

As regards moral and intellectual culture and instruction, it proposes nothing more, yet nothing less, than the system which has approved itself to the wise and learned of many generations. The religious training is to be more especially the duty of the parent and the church. It begins at the mother's knee, and its best and most effective lessons are learned before the period of college life. With strict impartiality as to the various shades of Christian belief, the moral character will here be guarded by vigilance and discipline from corrupting and immoral influences; and by diligent instruction be confirmed and strengthened in the great principles of faith and well living, which rise above all denominational differences and discussions.

In mental culture it adopts the course of studies of the most approved institution for training and disciplining the intellect and cultivating the taste; embracing the study of languages, spoken and unspoken; the mathematics in its several departments and applications; moral and intellectual philosophy; the physical sciences—those especially more immediately associated with agriculture; also the science of government, political economy, and political ethics.

In connection with such studies, a patriotism, which shall embrace his whole country, and a devotion to the republican principles of the government, will be faithfully instilled. Its teachings will rise above section and party; will know no difference of class, and acknowledge no personal superiority but what is due to worth and excellence of character.

The scheme of this agricultural college, in connection with an educational institution, embraces an experimental and model farm, with a plan for the advancement of agricultural science, based upon practice. It is proposed to institute a series of experiments, made under the most intelligent observation of facts, with an accurate and careful record of all the circumstances attending and bearing upon them. These experiments are to be made in the full light of all that science now professes to teach, but with absolute impartiality as to theories already in vogue, and the strictest reserve in adopting conclusions. Their design is to contribute in some degree to building up an agricultural science on the sure foundation of well ascertained facts. The farm, in its general management, it is proposed to make a model and an example of the best modes of culture in the several departments of agriculture. It is to be stocked with the best breeds of cattle, sheep, hogs, &c., and the most approved tools, implements, and machines. To complete the arrangements which a system so comprehensive demands, a commodious workshop is to be erected, with

motive power sufficient for all its purposes, and with space enough for exercise and instruction in most of the mechanic arts, at least for those operating in wood, iron, and stone.

In the year 1855, the legislature of South Carolina passed an act appropriating $5,000 per annum for agricultural purposes in that State, and for experiments, principally with the seeds, cuttings, &c., which may be obtained from the United States Patent Office.

Scientific schools, experimental grounds, and agricultural professorships have also been established in connection with many of the colleges and universities of the country, with the view of affording thorough and practical instructions in the arts and sciences, which bear directly upon rural affairs, as well as upon the other industrial occupations of the age.

In reverting to the progress of agriculture in the United States, it is obvious that, from the paucity of our statistics, prior to the year 1840, it would be difficult to arrive at any fixed ratio of increase or diminution of any particular product. The chief elements that would seem to have a bearing on these points consist in the augmentation of our population by birth, accession, or immigration; the annexation of territory; the demand for our staples, either for shipping or home consumption; the construction of railroads, telegraphs, and canals; the improvement of rivers and harbors; the introduction of improved implements of husbandry and labor-saving machinery; and last of all, in the permanent improvement or the overworking of the soil.

The following tables exhibit the general industrial and commercial condition of the country, as near as can be ascertained, with the population at each decennial period, since the formation of our government:

Synopsis of the principal Agricultural Products of the United States at different periods, with some of the results of the manufactures therefrom, and the imports and exports of articles similar in character which enter into our commerce.

CLASSIFICATION.	1790.	1800.	1810.	1820.	1830.	1840.	1850.
Animals, and their products—							
Animals imported for breed, value of...dollars..					18,563	20,503	88,965
Other animals imported, value of....dollars..						159,218	
Cattle, neat, in United States, total..number..						14,971,586	18,378,907
Milch cows in United States........number..							6,385,094
Working oxen in United States.......number..							1,700,744
Other cattle in United States.........number..							10,293,069
Value of animals slaughtered in the United States ....dollars..							111,703,142
Beef and pork imported.............pounds..					335,922	158,174	41,276
Value of ditto.................dollars..					6,690	3,629	1,267
Cattle, horned, domestic, exported...number..	4,627	8,486	8,522	5,018	5,881	7,861	1,350
Beef and pork, foreign, exported......pounds..					441,336	142,000	25,000
Value of ditto ....dollars..					18,287	3,495	937
Beef, domestic, exported..........barrels..	62,371	75,331	76,743	66,887	60,770	56,537	90,648
Dairy products of the United States, value of ....dollars..						33,787,008	425,881,199
Butter, domestic, produced..........pounds..							313,345,306
Value of ditto.................dollars..							50,135,248
Butter, imported..................pounds..					746	8,525	479,180
Value of ditto.................dollars..					104	992	37,536
Butter, domestic, exported...........pounds..	833,500	2,830,016	1,878,789	1,069,024	1,728,212	3,785,993	3,994,542
Cheese, imported ....pounds..	96,354	621,869	39,617	89,312	59,739	112,540	603,398
Value of ditto.................dollars..	7,708				7,277	14,812	54,852
Cheese, domestic, produced..........pounds..							105,535,893
Value of ditto ....dollars..							5,276,795
Cheese, foreign, exported...........pounds..			5,039	18,078	27,562	24,945	603,398
Value of ditto.................dollars..					3,897	4,448	54,852
Cheese, domestic, exported..........pounds..	120,901	1,674,834	944,116	766,431	1,131,817	1,748,471	10,361,189
Butter and cheese, domestic, exported, value of ....dollars..				190,287	264,796	504,815	1,124,652

Hides, imported, value of dollars	-----	-----	-----	892,530	3,057,543	3,457,248	5,964,838
Combs and buttons, domestic, exported, value of dollars	-----	-----	-----	-----	120,217	47,548	27,334
Hides, foreign, exported, value of dollars	-----	-----	-----	61,921	20,723	63,972	5,964,838
Hides, domestic, exported number	704	3,691	800	13,558	299,473	45,898	86,624
Glue, imported pounds	-----	-----	67,299	38,624	99,796	15,400	356,110
Value of ditto dollars	-----	-----	-----	-----	9,528	1,952	28,393
Glue, foreign, exported pounds	-----	-----	3,171	6,053	-----	-----	-----
Leather, sole and upper, imported pounds	-----	-----	-----	-----	-----	-----	352,937
Value of ditto dollars	-----	-----	-----	-----	-----	764,439	82,890
Tanned skins and skivers, imported number	-----	-----	-----	-----	-----	-----	1,273,284
Value of ditto dollars	-----	-----	-----	-----	-----	-----	1,089,168
Leather, foreign, exported, value of dollars	-----	-----	-----	-----	-----	20,194	-----
Leather, sole and upper, foreign, exported pounds	-----	-----	-----	-----	-----	-----	16,750
Value of ditto dollars	-----	-----	-----	-----	-----	-----	3,677
Skins, tanned and dressed, foreign, exported number	-----	-----	-----	-----	-----	-----	4,848
Value of ditto dollars	-----	-----	-----	-----	-----	-----	7,507
Leather, domestic, exported pounds	5,424	210,346	363,945	243,555	316,795	390,655	222,676
Leather and morocco skins, domestic, exported, value of dollars	-----	-----	-----	-----	58,146	38,689	13,309
Boots, shoes, and slippers, leather, imp'd pairs	77,190	94,207	8,792	7,995	13,465	37,290	42,291
Value of ditto dollars	65,368	-----	-----	6,445	-----	45,415	51,227
Boots, shoes, and slippers, leather, foreign, exported pairs	7,528	137,982	1,027	1,410	751	1,062	5,755
Value of ditto dollars	-----	-----	-----	2,244	1,522	1,309	3,792
Boots, leather, domestic, exported pairs	482	4,437	7,667	3,392	4,777	14,619	77,478
Shoes, leather, domestic, exported pairs	7,046	-----	42,993	187,889	257,150	83,853	205,198
Boots and shoes, leather, domestic, exported, value of dollars	-----	-----	-----	263,258	290,937	193,583	458,838
Boots, shoes, and slippers, silk, prunella, &c., imported pairs	-----	2,865	3,628	-----	5,626	4,964	304
Value of ditto dollars	-----	-----	-----	-----	-----	4,287	166
Boots, shoes, and slippers, silk, prunella, &c., foreign, exported pairs	-----	-----	982	-----	90	-----	2,232
Value of ditto dollars	-----	-----	-----	-----	-----	-----	847
Shoes and slippers, foreign and domestic, exported pairs	-----	133,545	-----	-----	-----	-----	-----

Synopsis of the principal Agricultural Products of the United States—Continued.

CLASSIFICATION.	1790.	1800.	1810.	1820.	1830.	1840.	1850.
Animals, and their products—Continued.							
Saddlery, domestic, exported, value of.. dollars..	....	1,976	14,677	41,172	39,440	22,456	30,100
Tallow, imported.......... pounds..	....	....	397,465	3,658,970	149,667	28,380	201,165
Value of ditto.......... dollars..	....	....	....	....	10,266	2,395	12,306
Tallow, foreign, exported.......... pounds..	....	....	....	80,212	968	36,718	66,440
Value of ditto.......... dollars..	....	....	....	....	97	2,942	1,510
Tallow, domestic, exported.......... pounds..	317,195	37,142	44,775	81,691	679,623	980,027	8,198,278
Horned cattle, beef, tallow, and hides, domestic, exported, value of.......... dollars..	....	....	....	698,323	829,982	904,918	1,689,958
Candles, tallow, imported.......... pounds..	6,929	196,668	67,959	574,201	22,774	29,783	400
Value of ditto.......... dollars..	693	....	....	....	1,559	3,208	28
Candles, stearine, imported.......... pounds..	....	....	....	....	....	....	38,435
Value of ditto.......... dollars..	....	....	....	....	....	....	7,531
Candles, wax and spermaceti, imported.. pounds..	576	3,047	5,248	996	307	3,029	46,944
Value of ditto.......... dollars..	288	....	....	....	117	1,645	16,215
Candles, tallow, foreign, exported.......... pounds..	....	....	26,100	95,208	24,397	23,239	1,645
Value of ditto.......... dollars..	....	....	....	....	2,302	2,826	117
Candles, stearine, foreign, exported.......... pounds..	....	....	....	....	....	....	19,200
Value of ditto.......... dollars..	....	....	....	....	....	....	5,490
Candles, wax and spermaceti, foreign, exported.......... pounds..	....	....	3,452	....	12,907	....	3,100
Value of ditto.......... dollars..	....	....	....	....	5,565	....	768
Candles, wax and spermaceti, domestic, exported.......... pounds..	118,625	315,559	257,979	....	847,384	599,657	538,549
Value of ditto.......... dollars..	....	....	....	....	217,830	231,960	195,916
Candles, tallow, domestic, exported.. pounds..	68,625	1,318,199	1,000,533	1,453,628	2,669,211	2,145,845	3,227,633
Soap, imported.......... pounds..	41,313	2,548,834	669,867	242,516	163,170	391,996	1,336,103
Value of ditto.......... dollars..	4,131	....	....	....	9,640	29,912	62,616
Soap, foreign, exported.......... pounds..	....	....	93,868	....	....	....	....
Soap, domestic, exported.......... pounds..	17,275	2,668,536	1,912,488	3,915,272	5,752,430	3,414,132	4,288,378
Soap and tallow candles, domestic, exported, value of.......... dollars..	....	....	....	661,409	643,252	494,577	609,732

Beeswax, produced in the United States, value of ...dollars..						628, 303	
Beeswax and honey, produced in the United States ...pounds..							14, 853, 790
Value of ditto...dollars..							2, 376, 606
Beeswax, domestic, exported ...pounds..	224, 538	177, 358	230, 350	241, 909	430, 929	254, 088	415, 923
Value of ditto...dollars..				85, 654	114, 017	74, 120	122, 835
Honey, domestic, exported ...gallons..	1, 740						
Bristles, hogs', imported ...pounds..				84, 867	245, 486	297, 806	465, 645
Value of ditto...dollars..					74, 776	150, 130	244, 694
Bristles, hogs', foreign, exported ...pounds..				30		3, 100	956
Value of ditto...dollars..						3, 508	478
Brushes, imported, value of ...dollars..					16, 741	60, 083	156, 413
Brushes, foreign, exported, value of ..dollars..					27	916	698
Brushes, domestic, exported, value of..dollars..					3, 947	2, 590	8, 257
Horses in the United States (except those in cities) ...number..							4, 336, 719
Asses and mules in the United States, total ...number..							559, 331
Horses, asses, and mules, in the United States, total ...number..						4, 335, 669	4, 896, 050
Horses, domestic, exported ...number..	6, 975	5, 085	2, 853	853	2, 184	2, 930	1, 364
Mules, domestic, exported...number..	444	483	198	94	1, 540	1, 418	2, 946
Horses and mules, domestic, exported, value of ...dollars..				59, 830	218, 015	293, 143	198, 155
Poultry in the United States, value of .dollars..						9, 344, 410	13, 000, 000
Eggs in the United States, value of...dollars..							5, 000, 000
Poultry, domestic, exported ...number..	122, 604	77, 484	20, 556				
Sheep in the United States, total ...number..						19, 311, 374	21, 723, 220
Sheep, domestic, exported...number..	10, 377	11, 621	5, 801	11, 117	8, 262	14, 639	4, 357
Value of ditto ...dollars..				22, 175	14, 499	35, 767	18, 875
Wool, produced in the United States .pounds..						35, 802, 114	52, 516, 959
Value of ditto...dollars..							15, 755, 087
Wool, imported ...pounds..				384, 333	5, 622, 960	596, 646	32, 548, 491
Value of ditto ...dollars..				93, 829	1, 288, 909	173, 672	3, 833, 157
Manufactures wholly or in part of wool, except those included in slippers and shoes, imported, value of ..dollars..				7, 238, 954	13, 089, 127	12, 933, 267	21, 290, 384

Synopsis of the principal Agricultural Products of the United States—Continued.

CLASSIFICATION.	1790.	1800.	1810.	1820.	1830.	1840.	1850.
Animals, and their products—Continued.							
Manufactures wholly or in part of wool, except those included in slippers and shoes, foreign, exported, value of ...dollars..	....	....	....	379,252	299,347	187,626	272,686
Silk, floss and raw, imported, value of...dollars..	....	....	....	....	88,557	254,102	456,449
Silk, piece goods, imported, value of ...dollars..	....	....	....	....	7,958,978	485,641	22,178,379
Bolting cloths, imported, value of ...dollars..	....	....	....	....	52,203	43,888	28,541
Sewing silk, imported, value of ...dollars..	....	....	....	....	701,728	393,093	379,455
Silk, other manufactures of, imported, value of ...dollars..	....	....	....	4,486,924	2,316,180	14,378,173	3,190,870
Silk, raw, foreign, exported, value of ...dollars..	....	....	....	....	134,376	227,113	43,856
Silk, piece goods, foreign, exported, value of ...dollars..	....	....	....	....	774,466	127,690	417,758
Bolting cloths, foreign, exported, value of ...dollars..	....	....	....	....	28	2,622	225
Sewing silk, foreign, exported, value of...dollars..	....	....	....	....	14,470	10,531	8,586
Silk, other manufactures of, foreign, exported, value of ...dollars..	....	....	....	....	262,817	215,421	73,599
Silk cocoons produced in the United States ...pounds..	....	....	....	....	....	61,652	10,843
Value of ditto ...dollars..	....	....	....	....	....	....	5,421
Skins and furs, domestic, exported, value of ...dollars..	....	281,639	313,915	766,205	750,938	993,262	977,762
Swine in the United States, total ...number..	....	....	....	....	....	26,301,293	30,354,213
Swine, domestic, exported ...number..	16,803	7,312	4,454	7,885	14,690	7,901	1,030
Bacon, imported ...pounds..	....	....	....	....	27,757	120,378	....
Value of ditto...dollars..	....	....	....	....	2,506	13,420	....
Bacon and hams, imported ...pounds..	....	....	....	....	....	....	136,273
Value of ditto...dollars..	....	....	....	....	....	....	13,456
Bacon and hams, foreign, exported ...pounds..	....	....	....	....	....	....	3,288
Value of ditto...dollars..	....	....	....	....	....	....	312

Bacon and hams, domestic, exported ..pounds..	295,647	2,034,630	1,286,809	1,607,506	1,477,446	2,794,517	18,027,302
Pork, domestic, exported ....barrels..	26,635	70,779	37,270	66,647	51,263	133,290	165,206
Lard, imported ....pounds..					5,778	80	2,672
Value of ditto ....dollars..					431	5	131
Lard, foreign, exported ....pounds..					5,758		
Value of ditto ....dollars..					491		
Lard, domestic, exported..........pounds..	522,715	2,376,500	1,927,451	3,996,561	6,963,516	10,597,654	19,683,082
Hogs, pork, bacon, hams, and lard, domestic, exported, value of........dollars..				1,354,116	1,501,644	2,621,537	4,368,015
Beer, ale, porter, cider, and vinegar—							
Beer, ale, and porter, imported, in casks ....gallons..	121,983	216,002	154,920	72,413	61,759	10,495	93,564
Value of ditto................dollars..	24,397			59,950	57,271	6,713	41,046
Beer, ale, and porter, imported, in bottles ....gallons..	42,042					99,785	264,028
Value of ditto................dollars..	37,277					98,469	209,848
Beer, ale, and porter, foreign, exported, in casks...............gallons..			3,744	5,674	4,780	417	1,500
Value of ditto ....dollars..				4,615	9,605	104	542
Beer, ale, and porter, foreign, exported, in bottles..............gallons..						1,096	4,932
Value of ditto ....dollars..						922	3,915
Beer, ale, porter, and cider, domestic, exported, in casks..............gallons..	95,346	128,588	216,691	87,592	76,856	106,017	143,014
Beer, ale, porter, and cider, domestic, exported, in bottles ....dozens..	1,029	8,307	33,875	14,456	17,875	19,763	15,122
Beer, ale, porter, and cider, domestic, exported, total value of...........dollars..						59,133	57,975
Vinegar, imported ....gallons..					36,523	76,658	46,925
Value of ditto ....dollars..					6,692	13,795	5,801
Vinegar, foreign, exported..........gallons..					2,786	1,436	1,228
Value of ditto ....dollars..					927	309	243
Vinegar, domestic, exported, value of..dollars..	562				7,178	12,957	16,915
Breadstuffs—							
Barley, produced in United States....bushels..						4,161,504	5,167,015
Value of ditto................dollars..							3,616,910
Barley, imported.................bushels..							95,663
Value of ditto................dollars..							53,653

Synopsis of the principal Agricultural Products of the United States—Continued.

CLASSIFICATION.	1790.	1800.	1810.	1820.	1830.	1840.	1850.
Breadstuffs—Continued.							
Barley, pearl, imported ... pounds							282,523
Value of ditto ... dollars							13,382
Barley, domestic, exported ... bushels	35	8,796	29,716				
Buckwheat, produced in U. States ... bushels						7,291,743	8,956,912
Value of ditto ... dollars							6,969,838
Buckwheat, domestic, exported ... bushels	14,499	154	150				
Buckwheat flour, domestic, exported ... barrels	422	636	189				
Corn, Indian, produced in U. States ... bushels						377,531,875	592,071,104
Value of ditto ... dollars							296,035,552
Corn, Indian, domestic, exported ... bushels	1,713,241	1,768,162	2,790,850	607,277	571,312	535,727	3,426,811
Value of ditto ... dollars				261,099	396,617	312,954	1,762,549
Corn-meal, domestic, exported ... barrels	70,339	306,452	147,425	131,669	207,604	232,284	203,622
Value of ditto ... dollars				345,180	595,434	682,457	622,866
Oats, produced in United States ... bushels						123,071,341	146,584,179
Value of ditto ... dollars							43,975,253
Oats, imported ... bushels					1,226	6,801	679,812
Value of ditto ... dollars					333	2,298	163,448
Oats, domestic, exported ... bushels	116,634	100,544	211,894				
Oat-meal, imported ... cwt							2,700
Value of ditto ... dollars							6,478
Oat-meal, domestic, exported ... bushels		347	12				
Peas and beans, produced in U. States ... bushels							9,219,901
Value of ditto ... dollars							5,762,436
Peas and beans, domestic, exported ... bushels	165,273	65,935	86,651				
Rice, produced in United States ... pounds						80,841,422	215,313,497
Value of ditto ... dollars							4,000,000
Rice, domestic, exported ... tierces	96,980	94,866	119,356	88,221	116,517	101,617	105,590
Value of ditto ... dollars				1,494,307	2,016,267	2,010,107	2,170,927
Rye, produced in United States ... bushels						18,645,567	14,188,813
Value of ditto ... dollars							7,803,847
Rye, imported ... bushels							67,454

Value of ditto ..... dollars							23, 158
Rye, domestic, exported ..... bushels	36, 737	31, 110	14, 818				
Rye-meal, imported ..... cwt							346
Value of ditto ..... dollars							486
Rye-meal, domestic, exported ..... barrels	24, 062	130, 758	29, 375	23, 523	19, 100	44, 031	44, 152
Value of ditto ..... dollars				55, 226	71, 881	138, 505	145, 802
Rye, oats, and other small grain and pulse, domestic, exported, value of ..... dollars				47, 137	132, 717	159, 893	120, 670
Wheat, produced in United States ..... bushels						84, 823, 272	100, 485, 944
Value of ditto ..... dollars							100, 485, 944
Wheat, imported ..... bushels					620	632	870, 889
Value of ditto ..... dollars					685	653	609, 681
Wheat, foreign, exported ..... bushels						632	451, 874
Value of ditto ..... dollars						653	478, 336
Wheat, domestic, exported ..... bushels	1, 018, 339	239, 929	216, 833	25, 821	408, 910	868, 585	1, 026, 725
Value of ditto ..... dollars				20, 925	523, 270	822, 881	1, 025, 732
Wheat flour, imported ..... cwt					5	86	496, 201
Value of ditto ..... dollars					14	247	1, 008, 929
Wheat flour, domestic, exported ..... barrels	619, 681	1, 102, 444	1, 445, 012	1, 056, 119	1, 806, 525	1, 515, 817	2, 202, 335
Value of ditto ..... dollars				4, 298, 043	9, 938, 458	7, 759, 646	10, 524, 331
Wheat flour, foreign, exported ..... cwt							486, 075
Value of ditto ..... dollars							1, 278, 943
Biscuit, shipbread or crackers, domestic, exported ..... barrels	100, 279	105, 983	103, 901	47, 509	67, 113	103, 995	106, 399
Biscuit, shipbread or crackers, domestic, exported ..... kegs	15, 346	44, 079	47, 536	31, 370	46, 048	39, 410	34, 815
Biscuit, shipbread or crackers, domestic, exported, total value of ..... dollars				157, 389	250, 533	378, 041	254, 286
Starch, imported ..... pounds			9, 402				41, 996
Value of ditto ..... dollars							3, 360
Starch, foreign, exported ..... pounds			612				
Starch, domestic, exported ..... pounds	160	203, 360	1, 200				
Bricks and lime—							
Bricks, domestic, exported ..... number	737, 764	666, 817	225, 000				
Lime, domestic, exported ..... bushels	1, 320						
Bricks and lime, domestic, exported, value of ..... dollars					4, 412	14, 064	22, 045
Coal, imported ..... bushels	202, 040	665, 059	370, 687	627, 737	1, 022, 245	4, 351, 032	7, 731, 864
Value of ditto ..... dollars	25, 255			91, 352	108, 250	369, 352	479, 785

Synopsis of the principal Agricultural Products of the United States—Continued.

CLASSIFICATION.	1790.	1800.	1810.	1820.	1830.	1840.	1850.
Coal—Continued.							
Coal, foreign, exported .... bushels	3,788	16,334	1,976	8,318	4,329	474,229	12,384
Value of ditto .... dollars	....	....	....	2,450	998	76,040	1,690
Coal, domestic, exported .... tons	....	....	....	....	....	....	37,727
Value of ditto .... dollars	....	....	....	....	....	....	163,977
Cocoa and chocolate, imported .... pounds	1,053,390	6,210,390	2,565,930	1,921,842	2,845,162	2,509,637	2,198,609
Value of ditto .... dollars	90,862	....	....	231,593	154,578	223,909	127,360
Cocoa and chocolate, foreign, exported .... pounds	8,322	7,060,878	2,221,472	1,504,872	1,783,590	1,752,029	1,107,280
Value of ditto .... dollars	....	....	....	228,219	175,047	208,985	72,251
Chocolate, domestic, exported .... pounds	....	....	16,173	10,369	17,534	22,529	26,627
Value of ditto .... dollars	....	....	....	2,166	1,965	2,606	3,255
Coffee, imported .... pounds	4,478,676	57,383,904	30,062,366	21,273,659	81,757,386	114,984,783	152,519,743
Value of ditto .... dollars	580,713	....	....	4,489,970	6,317,666	10,444,882	12,851,070
Coffee, foreign, exported .... pounds	962,977	45,106,494	10,261,136	9,387,596	6,056,629	5,784,536	3,527,238
Value of ditto .... dollars	....	....	....	2,087,479	521,527	589,609	361,399
Cotton and its manufactures—							
Cotton produced in the United States .... pounds	....	....	....	....	....	790,479,200	978,317,200
Value of ditto .... dollars	....	....	....	....	....	....	98,603,720
Cotton, imported .... pounds	333,124	4,156,926	333,748	691,039	345,459	3,182,008	157,757
Value of ditto .... dollars	82,884	....	....	140,616	33,475	281,180	11,281
Cotton, foreign, exported .... pounds	....	....	127,848	486,753	335,012	2,603,718	....
Value of ditto .... dollars	....	....	....	104,255	27,277	245,078	....
Cotton, domestic, exported, total .... pounds	189,316	20,911,201	62,058,236	124,893,405	276,979,784	530,204,100	927,237,089
Value of ditto .... dollars	....	....	....	20,157,484	25,289,492	54,330,341	112,315,317
Cotton, Sea Island, domestic, exported .... pounds	....	....	8,029,576	11,344,066	8,311,762	6,237,424	8,299,656
Other cotton, domestic, exported .... pounds	....	....	54,028,660	113,549,339	268,668,022	523,966,676	918,937,433
Cotton-seed, domestic, exported .... bushels	109	....	....	....	....	....	....
Manufactures, wholly or in part of cotton, except those mixed with wool, slippers and shoes, imported, value of .... dollars	....	....	....	7,390,928	17,170,598	12,480,714	22,257,752

Foreign manufactures, wholly or in part of cotton, except those mixed with wool, slippers and shoes, exported, value of ......dollars..	......	......	......	1,581,143	3,245,381	939,543	93,951
Domestic manufactures, wholly or in part of cotton, except those mixed with wool, slippers and shoes, exported, value of ......dollars..	......	......	......	......	1,126,313	3,122,546	7,241,205
Drugs, dyes, and condiments—							
Ginseng, domestic, exported ......pounds..	29,208	286,458	314,131	352,992	357,002	640,967	196,510
Value of ditto......dollars..	......	......	......	171,786	115,928	437,245	100,549
Indigo, imported ......pounds..	53,257	421,792	805,378	584,805	803,252	......	1,003,284
Value of ditto......dollars..	53,257	......	......	704,412	759,012	......	675,087
Indigo, foreign, exported......pounds..	......	......	555,030	254,143	238,218	69,149	78,987
Value of ditto......dollars..	......	......	......	416,968	278,997	106,291	79,498
Indigo, domestic, exported ......pounds..	497,720	411,140	19,090	1,004	......	......	2,740
Value of ditto......dollars..	......	......	......	714	......	......	2,803
Woad, imported ......pounds..	......	......	......	......	......	......	43,693
Value of ditto......dollars..	......	......	......	......	......	......	1,429
Oak bark, and other dye, domestic, exported, value of ......dollars..	......	31,043	111,825	139,534	99,116	153,519	355,477
Pepper, red or Cayenne, imported......pounds..	......	......	......	......	777	42	78,069
Value of ditto......dollars..	......	......	......	......	......	14	4,899
Salt, imported ......bushels..	1,850,479	3,054,107	......	3,943,727	4,182,340	6,823,944	8,681,176
Value of ditto......dollars..	185,048	......	......	609,021	535,138	821,495	1,047,890
Salt, foreign, exported ......bushels..	......	......	898	31,440	55,689	72,912	76,556
Value of ditto......dollars..	......	......	......	15,321	13,353	23,466	22,590
Salt, domestic, exported......bushels..	4,208	70,067	......	......	45,847	215,084	344,061
Value of ditto ......dollars..	......	......	......	......	26,848	62,765	61,424
Fertilizers—							
Guano, imported......tons...	......	......	......	......	......	......	23,153
Value of ditto ......dollars..	......	......	......	......	......	......	97,881
Guano, foreign, exported......tons...	......	......	......	......	......	......	537
Value of ditto ......dollars..	......	......	......	......	......	......	13,759
Gypsum, or plaster, unground, imported, value of ......dollars..	......	......	......	141,369	119,444	100,676	73,088
Flax and hemp, and their manufactures—							
Flax produced in the United States...pounds..	......	......	......	......	......	......	7,709,676
Value of ditto ......dollars..	......	......	......	......	......	......	770,968

Synopsis of the principal Agricultural Products of the United States—Continued.

CLASSIFICATION.	1790.	1800.	1810.	1820.	1830.	1840.	1850.
Flax and hemp—Continued.							
Flax, imported ... cwt	...	...	...	...	463	...	21,171
Value of ditto ... dollars	...	...	...	...	6,472	...	176,197
Flax, domestic, exported ... pounds	18,600	28,960	32,200	...	...	...	...
Flax and hemp, produced in United States ... tons	...	...	...	...	...	95,251	38,725
Hemp, dew-rotted, produced in the United States ... tons	...	...	...	...	...	...	33,193
Hemp, water-rotted, produced in the United States ... tons	...	...	...	...	...	...	1,678
Value of hemp produced in the United States ... dollars	...	...	...	...	...	...	5,247,430
Hemp, imported ... cwt	17,827	44,749	228,487	86,192	51,909	72,962	37,530
Value of ditto ... dollars	59,897	...	...	510,489	295,706	561,039	228,984
Hemp, foreign, exported ... cwt	...	...	...	...	...	5	1,348
Value of ditto ... dollars	...	...	...	...	...	50	7,876
Hemp, domestic, exported ... cwt	15	561	1	...	...	...	4,769
Value of ditto ... dollars	...	...	...	...	...	...	29,114
Hemp, Manilla, sun, Indian, &c., imported ... cwt	...	...	...	...	...	...	198,338
Value of ditto ... dollars	...	...	...	...	...	...	508,709
Hemp, Manilla, sun, Indian, &c., foreign, exported ... cwt	...	...	...	...	...	...	2,082
Value of ditto ... dollars	...	...	...	...	...	...	8,688
Hemp, Sisal, coir, jute, &c., imported ... cwt	...	...	...	...	...	...	38,379
Value of ditto ... dollars	...	...	...	...	...	...	201,316
Hemp, Sisal, coir, jute, &c., foreign, exported ... cwt	...	...	...	...	...	...	1,235
Value of ditto ... dollars	...	...	...	...	...	...	3,158
Flaxseed, produced in United States ... bushels	...	...	...	...	...	...	562,312
Value of ditto ... dollars	...	...	...	...	...	...	843,468
Flaxseed, imported ... bushels	...	...	...	...	...	...	12,040

Value of ditto .... dollars..							430,017
Flaxseed, foreign, exported .... bushels..							170
Value of ditto .... dollars..							130
Flaxseed, domestic, exported .... bushels..	292,460	461,266	304,114	264,310	120,702	32,243	9,185
Value of ditto .... dollars..				420,202	216,376	50,781	18,988
Linseed oil, imported .... gallons..					118,556	476,125	2,818,344
Value of ditto .... dollars..						234,984	1,632,811
Linseed oil, foreign, exported .... gallons..					7,946	8,995	17,651
Value of ditto .... dollars..						7,152	13,354
Linseed oil, domestic, exported .... gallons..	90	31,564	35,597	16,370	8,643	10,072	20,193
Linseed oil and spirits of turpentine, domestic, exported, value of .... dollars..				20,532	54,092	52,162	145,410
Flax, manufactures of, wholly or in part, except those mixed with wool, slippers and shoes, imported, value of .... dollars..				2,564,159	4,014,792	6,853,093	9,018,855
Flax, foreign, manufactures of, wholly or in part, except those mixed with wool, slippers and shoes, exported, value of .... dollars..				245,848	907,129	280,459	116,107
Flax, domestic, manufactures of, wholly or in part, except those mixed with wool, slippers and shoes, exported, value of .... dollars..					2,830	13,400	8,023
Hemp, manufactures of, imported, all kinds, value of .... dollars..	52,363			1,228,317	1,590,983	2,127,345	1,574,422
Hemp, foreign, manufactures of, exported, all kinds, value of .... dollars..				467,112	504,605	182,179	176,657
Hemp, domestic, manufactures of, exported, all kinds, value of .... dollars..				26,662	6,109	31,582	52,054
Old junk, imported, value of .... dollars..							37,987
Rags of all kinds, imported .... pounds..							26,094,701
Value of ditto .... dollars..					276,617	496,227	903,747
Fruits and nuts—							
Almonds, imported .... pounds..			175,908	264,818	1,189,589	815,195	2,854,804
Value of ditto .... dollars..					233,033	58,573	233,305
Almonds, foreign, exported .... pounds..			7,661	38,914	91,435	74,975	45,036
Value of ditto .... dollars..						11,198	4,050
Apples, domestic, exported .... barrels..	12,352	9,022	16,321	22,881	16,375	25,216	28,842

Synopsis of the principal Agricultural Products of the United States—Continued.

CLASSIFICATION.	1790.	1800	1810.	1820.	1830.	1840.	1850.
Fruits and nuts—Continued.							
Value of ditto ... dollars				39,966	31,148	48,396	71,367
Cranberries, domestic, exported ... bushels	720						
Currants, imported ... pounds			78,483	24,688	233,033	1,135,756	3,249,488
Value of ditto ... dollars					96,948	103,441	133,870
Currants, foreign, exported ... pounds			3,181	100	2,287	2,066	234,592
Value of ditto ... dollars						257	11,831
Dates, imported ... pounds							458,178
Value of ditto ... dollars							4,393
Dates, foreign, exported ... pounds							8,721
Value of ditto ... dollars							396
Figs, imported ... pounds			216,982	259,617	1,251,823	1,989,585	3,448,799
Value of ditto ... dollars						85,944	135,559
Figs, foreign, exported ... pounds			25,348	9,263	385,504	62,173	72,979
Value of ditto ... dollars						5,125	6,648
Orchard products of United States, value of ... dollars						7,256,904	7,723,186
Prunes and plums, imported ... pounds			27,104	125,300	96,948	681,016	1,424,659
Value of ditto ... dollars						43,107	81,773
Prunes and plums, foreign, exported ... pounds			1,500	4,644	6,860	31,165	12,969
Value of ditto ... dollars						3,641	2,171
Raisins, imported ... pounds			1,621,437	2,204,450	7,480,746	14,664,100	18,286,712
Value of ditto ... dollars					3,588,050	784,574	879,591
Raisins, foreign, exported ... pounds	400		77,010	122,419	576,269	452,165	689,104
Value of ditto ... dollars				15,373	78,823	33,881	51,159
Nuts, imported ... pounds							4,619,261
Value of ditto ... dollars							128,296
Nuts, foreign, exported ... pounds							493,097
Value of ditto ... dollars							12,485
Hay, produced in the United States ... tons						10,248,108	13,838,642
Value of ditto ... dollars							96,870,494
Hay, domestic, exported ... tons	2,006						

Hops, produced in the United States ----pounds--						1,238,502	3,497,029
Value of ditto ----dollars--							1,222,960
Hops, domestic, exported----pounds--	650	70,784		319,501	265,043	176,619	110,360
Value of ditto ----dollars--				18,498	26,664	28,823	11,636
Ice, domestic, exported, value of ----dollars--							106,805
Oils, vegetable—							
Oil, castor, imported----gallons--					67	6,979	22,184
Value of ditto ----dollars--						7,300	15,047
Oil, castor, foreign, exported ----gallons--					599		265
Value of ditto ----dollars--							290
Oil, olive, imported----gallons--				49,530	234,647	95,548	164,314
Value of ditto ----dollars--						74,437	106,889
Oil, olive, foreign, exported----gallons--				1,755	19,215	3,873	4,605
Value of ditto ----dollars--				2,046		4,396	3,576
Oil, rape-seed, imported ----gallons--					13	49	2,644
Value of ditto ----dollars--						53	1,618
Potatoes, all kinds, produced in the United States----bushels--						108,298,060	104,066,944
Value of ditto ----dollars--							45,453,232
Potatoes, common, produced in United States----bushels--							65,797,896
Value of ditto ----dollars--							26,319,158
Potatoes, sweet, produced in the United States----bushels--							38,268,148
Value of ditto ----dollars--							19,134,074
Potatoes, common, imported----bushels--					24,521	45,882	299,132
Value of ditto ----dollars--					7,818	17,052	94,441
Potatoes, domestic, exported----bushels--	22,263	104,136	76,755	90,889	112,875	136,095	106,342
Value of ditto ----dollars--				30,500	41,147	64,402	79,314
Seeds, trees, shrubs, and plants—							
Nursery products of United States, value of ----dollars--						593,534	
Garden seeds, trees, shrubs, plants, &c., imported, value of ----dollars--							168,386
Garden seeds, trees, shrubs, plants, &c., foreign, exported, value of ----dollars--							1,611
Clover-seed, produced in the United States----bushels--							468,978
Value of ditto ----dollars--							2,344,890

Synopsis of the principal Agricultural Products of the United States—Continued.

CLASSIFICATION.	1790.	1800.	1810.	1820.	1830.	1840.	1850.
Seeds, trees, shrubs, and plants—Continued.							
Other grass seeds, produced in United States ..... bushels..	-----	-----	-----	-----	-----	-----	416,831
Value of ditto ..... dollars..	-----	-----	-----	-----	-----	-----	833,662
Spirits and wine—							
Brandy, imported ..... gallons..	-----	-----	-----	-----	-----	-----	3,163,783
Value of ditto ..... dollars..	-----	-----	-----	-----	-----	-----	2,128,679
Brandy, foreign, exported ..... gallons..	158	-----	-----	-----	-----	-----	86,476
Value of ditto ..... dollars..	-----	-----	-----	-----	-----	-----	80,072
Cordials, imported ..... gallons..	-----	-----	-----	-----	-----	-----	33,286
Value of ditto ..... dollars..	-----	-----	-----	-----	-----	-----	34,127
Cordials, foreign, exported ..... gallons..	207	-----	-----	-----	-----	-----	2,494
Value of ditto ..... dollars..	-----	-----	-----	-----	-----	-----	3,080
Spirits, except foreign brandy and cordials, imported ..... gallons..	3,967,707	7,932,982	4,143,264	3,658,150	2,491,523	3,202,134	1,294,731
Value of ditto ..... dollars..	1,859,975	-----	-----	1,804,798	1,037,737	1,743,237	465,054
Spirits, except foreign brandy and cordials, exported ..... gallons..	29,503	520,205	135,625	254,816	639,300	217,366	42,857
Value of ditto ..... dollars..	-----	-----	-----	165,160	226,374	171,417	26,311
Spirits from grain, domestic, exported, gallons..	753	16,920	500,918	-----	326,491	328,791	95,245
Value of ditto ..... dollars..	-----	-----	-----	-----	141,794	97,150	36,084
Spirits from molasses, domestic exported ..... gallons..	513,234	320,649	344,455	840,761	110,554	1,281,142	756,246
Value of ditto ..... dollars..	-----	-----	-----	280,648	34,569	371,234	339,622
Wine, produced in the United States .. gallons..	-----	-----	-----	-----	-----	124,734	221 249
Value of ditto ..... dollars..	-----	-----	-----	-----	-----	-----	442,498
Wines, imported, all kinds ..... gallons..	1,078,186	2,718,326	1,898,609	3,215,142	3,690,062	4,980,718	6,067,740
Value of ditto ..... dollars..	836,122	-----	-----	1,873,464	1,673,058	2,091,411	2 359,279
Wines, foreign, exported, all kinds ... gallons..	108,811	1,531.752	344,521	329,732	321,118	203,660	550,185
Value of ditto ..... dollars..	-----	-----	-----	240,929	181,627	145,585	245,913

Sugar and molasses—							
Sugar, produced in United States, total..pounds..	----	----	----	----	----	----	271,386,436
Value of ditto ..dollars..	----	----	----	----	----	----	14,091,521
Sugar, cane, produced in the United States..pounds..	----	----	----	----	----	----	237,133,000
Value of ditto ..dollars..	----	----	----	----	----	----	12,378,850
Sugar, maple, produced in the United States..pounds..	----	----	----	----	----	----	34,253,436
Value of ditto ..dollars..	----	----	----	----	----	----	1,712,671
Sugar, brown, imported ..pounds..	24,356,594	96,929,621	317,955	53,145,654	98,576,928	165,963,083	363,537,861
Value of ditto ..dollars..	1,608,580	----	----	----	4,220,993	7,605,830	12,882,274
Sugar, white, clayed, or powdered, imported ..pounds..	----	----	18,880,615	6,367,181	10,437,726	18,233,579	4,786,437
Value of ditto ..dollars..	----	----	----	----	689,884	1,192,207	235,732
Sugar, loaf and other refined, imported, pounds..	545,045	39,699,315	149	----	216,514	68,219	12,077,726
Value of ditto ..dollars..	67,576	----	----	----	20,947	4,671	723,420
Sugar candy, imported ..pounds..	----	----	1,875	2,866	----	114	21,280
Value of ditto ..dollars..	----	----	----	313	----	34	4,469
Sugar, brown, foreign, exported ..pounds..	73,304	97,565,732	5,189,885	15,548,582	17,297,837	2,055,567	3,795,625
Value of ditto ..dollars..	----	----	----	----	86,564	120,970	187,651
Sugar, white, clayed, or powdered, foreign, exported ..pounds..	----	----	13,076,776	4,512,430	5,274,579	9,755,666	1,884,188
Value of ditto ..dollars..	----	----	----	----	404,993	730,721	103,229
Sugar, loaf, and other refined, foreign, exported ..pounds..	2,357	168,479	1,686	713	8,495	3,033	1,107,295
Value of ditto ..dollars..	----	----	----	----	779	243	71,837
Sugar, brown, domestic, exported ..pounds..	----	----	----	24,592	180,132	312,864	561,828
Value of ditto ..dollars..	----	----	----	1,975	10,105	23,837	29,170
Sugar, refined, domestic, exported ..pounds..	----	----	71,230	156,527	2,057,487	13,435,084	2,689,541
Value of ditto ..dollars..	----	----	----	24,051	215,794	1,348,974	219,588
Sugar, maple, domestic, exported ..pounds..	----	----	173,012	----	----	----	----
Molasses, produced in United States ..gallons..	----	----	----	----	----	----	12,700,991
Value of ditto ..dollars..	----	----	----	----	----	----	2,540,179
Molasses, imported ..gallons..	7,194,606	5,717,290	8,634,418	9,086,982	17,085,878	19,355,028	36,376,772
Value of ditto ..dollars..	1,438,921	----	----	1,719,227	2,432,488	2,628,519	3,707,581
Cane syrup, imported ..pounds..	----	----	----	----	----	----	265
Value of ditto ..dollars..	----	----	----	----	----	----	45
Molasses, foreign, exported ..gallons..	12,721	421,628	18,837	39,421	312,142	328,786	226,592
Value of ditto ..dollars..	----	----	----	11,232	17,695	85,586	44,258

Synopsis of the principal Agricultural Products of the United States—Continued.

CLASSIFICATION.	1790.	1800.	1810.	1820.	1830.	1840.	1850.
Sugar and molasses—Continued.							
Molasses, domestic, exported, value of..dollars..	----------	----------	----------	----------	948	7,999	16,830
Tea, imported..........pounds..	1,305,428	3,823,809	2,850,200	4,975,646	5,182,867	11,560,301	17,461,114
Value of ditto..........dollars..	352,510	----------	----------	1,322,636	1,418,037	3,466,245	4,798,005
Tea, foreign, exported..........pounds..	----------	1,409,253	1,025,962	389,423	526,186	660,832	3,956,340
Value of ditto..........dollars..	----------	----------	----------	242,372	360,509	291,250	1,345,504
Tobacco and its manufactures—							
Tobacco produced in United States...pounds..	----------	----------	----------	----------	----------	219,163,319	199,752,655
Value of ditto..........dollars..	----------	----------	----------	----------	----------	----------	13,982,686
Tobacco, imported..........pounds..	----------	166,815	----------	----------	----------	----------	4,029,921
Value of ditto..........dollars..	----------	----------	----------	----------	----------	----------	555,608
Cigars, imported..........thousand..	----------	----------	13,937	11,000	39,212	98,898	218,792
Value of ditto..........dollars..	----------	----------	----------	113,601	433,457	1,254,203	2,520,812
Snuff, imported..........pounds..	1,380	25,207	1,347	2,310	4,075	229	1,498
Value of ditto..........dollars..	276	----------	----------	----------	2,365	131	353
Other manufactures of tobacco, imported..........pounds..	----------	----------	18,114	40	75	2,452	42,249
Value of ditto..........dollars..	----------	----------	----------	----------	24	669	12,550
Tobacco, foreign, exported..........pounds..	----------	----------	----------	----------	----------	----------	275,288
Value of ditto..........dollars..	----------	----------	----------	----------	----------	----------	50,845
Cigars, foreign, exported..........thousand..	----------	----------	2,373	1,095	----------	7,474	8,445
Value of ditto..........dollars..	----------	----------	----------	13,935	----------	86,829	167,309
Snuff, foreign, exported..........pounds..	----------	----------	64	2,338	8,231	----------	8
Value of ditto..........dollars..	----------	----------	----------	782	3,393	----------	8
Other manufactures of tobacco, foreign, exported..........pounds..	----------	----------	----------	----------	----------	----------	211
Value of ditto..........dollars..	----------	----------	----------	----------	----------	----------	211
Tobacco, domestic, exported..........hogsheads..	101,272	103,758	35,828	66,858	86,718	147,828	95,945
Value of ditto..........dollars..	----------	----------	2,150,000	5,648,962	4,892,388	12,576,703	9,219,251
Snuff, domestic, exported..........pounds..	15,689	52,297	19,840	44,552	27,967	68,553	37,422
Tobacco, manufactured, domestic, exported..........pounds..	81,122	472,282	732,713	1,332,949	3,639,856	7,503,644	7,235,358

Snuff and tobacco, manufactured, domestic, exported, value of .... dollars..	....	....	....	149,083	292,475	873,877	1,143,547
Wood and its products—							
Ashes, pot and pearl, domestic, exported .... tons..	6,281	8,525	5,846	8,553	10,219	5,565	5,918
Value of ditto .... dollars..	....	....	....	889,348	935,613	573,026	649,091
Boards, planks, and scantling, domestic, exported .... M. feet..	47,954	71,630	85,340	76,241	65,045	93,049	100,604
Hewn timber, domestic, exported .... tons..	13,775	9,657	116.428	15,220	32,335	61,249	13,372
Shingles, domestic, exported .... thousand..	74,206	81,044	69,097	53,583	33,122	37,759	34,871
Staves and heading, domestic, exported .... thousand..	29,062	37,189	30,284	25,506	22,838	42,507	33,006
Boards, planks, scantling, hewn timber, shingles, staves, and heading, domestic, exported, value of .... dollars..	....	....	....	1,367,660	1,467,065	2,549,812	2,348,621
Masts and spars, domestic, exported, value of .... dollars..	....	....	108,020	54,627	7,806	58,991	70,095
Other lumber, domestic, exported, value of .... dollars..	....	....	....	90,521	214,105	266,175	205,190
Rosin and turpentine, domestic, exported .... barrels..	53,335	37,810	113,654	79,213	156,319	244,846	387,220
Tar and pitch, domestic, exported .... barrels..	54,852	70,169	161,171	71,196	52,995	77,019	112,971
Tar, pitch, rosin, and turpentine, domestic, exported, value of .... dollars..	....	....	....	314,660	397,687	684,514	1,063,842
Spirits of turpentine, domestic, exported .... gallons..	1,172	4,783	43,133	19,016	131,934	107,640	363,828
Cork tree, bark of, unmanufactured, imported, value of .... dollars..	....	....	....	....	1,264	4,403	19,309
Corks, imported, value of .... dollars..	....	....	....	....	31,455	54,592	131,181
Other manufactures of cork, imported, value of .... dollars..	....	....	....	....	....	....	1,024
Corks, foreign, exported, value of .... dollars..	....	....	....	....	130	2,585	1,433

Summary of the population of the United States at different periods.

CLASSIFICATION.	1790.	1800.	1810.	1820.	1830.	1840.	1850.
Total population, except Indians	3,929,827	5,305,925	7,239,814	9,638,131	12,866,020	17,069,453	23,191,876
Males				4,898,127	6,529,696	8,688,532	11,837,661
Females				4,740,004	6,336,324	8,380,921	11,354,215
Increase per cent. of whole population for each period, Indians excepted		35.02	36.45	33.13	33.49	32.67	35.87
White males	1,615,625	2,204,421	2,987,571	3,995,133	5,355,133	7,255,534	10,026,402
White females	1,556,839	2,100,068	2,874,433	3,866,804	5,171,115	6,940,161	9,526,666
Whites, total	3,172,464	4,304,489	5,862,004	7,861,937	10,526,248	14,195,695	19,553,068
Free colored males				114,966	153,453	186,481	208,724
Free colored females				123,190	166,146	199,822	225,771
Free colored, total	59,466	108,395	186,446	238,156	319,599	386,303	434,495
Slaves, males				788,025	1,012,823	1,246,517	1,602,535
Slaves, females				750,100	996,220	1,240,938	1,601,778
Slaves, total	697,897	893,041	1,191,364	538,125	2,009,043	2,487,455	3,204,313
Foreign born							2,240,581
Insane and idiotic						14,641	29,229
Deaf and dumb					5,363	6,684	9,136
Blind					3,974	5,024	7,978
Farmers							2,400,583
Indians (assumed)	76,000						500,000
Immigrants, males				6,447	7,514	58,998	200,904
Immigrants, females				2,680	3,575	33,158	113,392
Immigrants, sex not stated				1,184	13,748	51	1,038
Immigrants, total (assumed prior to 1820)	4,000	5,000	5,000	10,311	24,837	92,207	315,334
Immigrants, farmers				874	1,424	18,476	42,873
Immigrants, mechanics				269	942	9,474	23,378

By examining the preceding tables, it will be seen that, notwithstanding the abundance and cheapness of virgin soil, the advantages of climate, the facility of transportation to available markets, and the untrammelled, lightly-taxed, and independent condition of our farmers and planters, the ratio of increase of the agricultural products of the United States in the several decennial periods is, in general, far below that of the increment of population, accession of territory, extension of commerce, manufactures, internal improvements, and the modern appliances for economizing labor. This apparent decadence may be attributed chiefly to the deterioration of the soil in many parts of the older-settled portions of our territory, caused by injudicious culture, a want of a proper regard to the allotment and rotation of crops, the increased devotion of labor and capital to manufactures, commerce, and mines, an advance in the rates of wages, as well as in the expense of living, and the augmentation of taxes for the support of paupers and the punishment of crime.

Of all causes most likely to be instrumental in the future development or retardation of agriculture in this country, probably the increase of population is the one to which we should direct our attention with the most watchful interest. As inhabitants multiply, their demands for the produce of the earth for support will annually increase, and to meet this demand, a corresponding tillage and application of labor to the soil, guided by science, intelligence, and modern improvements, must necessarily follow. An experimental farm should be established and conducted under the direction of a well-organized society in every populous county in the United States, the results of which should be widely disseminated, with other agronomic knowledge, through public journals and authentic reports; agricultural education should be advanced by the institution of special and elementary schools in the various States; and an effectual plan should be devised for a friendly co-operation of the agricultural societies to prevent jealousies and inspire confidence throughout the land. Our soil should be renovated and maintained in its fertility by an increase of dairy and stock-farms, by means of the manure produced thereon; by the judicious application of lime, gypsum, guano, bone-dust, marl, swamp-muck, &c., as well as by converting the sewage of cities and towns into fertilizing compounds, thereby promoting the health of the inhabitants, and serving the purpose of two ends; stiff and clayey soils should be ameliorated by under-drainage, with the object of rendering them permeable so as to admit moisture and air, which, together, contain the principal elements of vegetable nutrition; light soils should be made more adhesive by the compacting tread of animals in "folding," or the out-door consumption of green forage or root-crops in the field. The best means should be devised for converting grass-lands into tillage, without exhausting the soil, and of returning the same to grass after a certain period in an amended state, or at least without injury. New plants should be adopted into the rotation of crops, either by introducing them from abroad, or by improving those already existing in the country by change of locality, hybridization, or the selection of seed. Vineyards and

orchards should be increased throughout the land for promoting the blessings of temperance and health. Plantations of timber-trees should be established for furnishing, in future, materials for naval and civil architecture and the arts, thus laying the foundation of forest-culture. Our agricultural, mineral, and forest resources should be developed by the extension of railroads, canals, and other channels of intercommunication, in all cases which would justify the expense. Capital should be invested in joint-stock companies, or otherwise, for rearing and improving domestic animals; for the production and manufacture of manures; the raising and preparation for market of the Cereal grains, cotton, flax, hemp, tobacco, sugar, molasses, tea, fruit, wine, &c.; for directing the agricultural portion of immigrants into proper channels, and extending to those pioneer farmers all possible aid and support in their hazardous and laborious undertakings; for the remedying of pauperism and preventing crime by persuading, and coercing, if necessary, the idle and the vagrant to engage in some useful employment, and thus, by furnishing food and profitable labor for the poor, to lay the foundation of moral as well as of physical good.

D. J. B.

ANIMALS.

ADAPTATION OF THE ENGLISH DRAUGHT HORSE FOR CITY OR TOWN WORK.

The existing cart-horse of England is not an aboriginal breed of that country, but was imported from the neighboring Continent since the Norman conquest. Indeed, there is reason to believe that the horses employed in the army of William the Conqueror were little better than the draught horses of the present day. So long as armor was in fashion, a large massive animal was required to support the enormous weight of the steel-clad knight, and to withstand the ponderous attack of a similar opponent. The half-bred horse was then unknown, and the Barb and the Spanish horse were insufficient in size; so that recourse was had to the large black horse which had been known throughout the fertile plains of Europe from time immemorial, and from which, no doubt, the greater portion of the English cart-horses are descended. This race is pretty generally distributed throughout the country, and may be divided, in fact, into three kinds: First, the heavy massive horse, reared in the rich marshes and plains of the midland counties expressly for the London brewers; second, the smaller-sized but still tolerably heavy horse, generally employed for agricultural purposes, a strong, compact animal, but slow in action; and third, a lighter and a more active animal, possessing either some admixture of blood of a smaller breed, or being the descendant of the Flanders discarded coach-horse.

The most prevailing color amongst these animals is black, so much so that we recognize a distinct breed under the appellation of the "Old Black Cart-horse;" but the large dray is by no means confined to those of a black color. There are many of a bay, and still more of a brown color, as well as numerous greys and roans. There are also very many excellent compact cart-horses, of these various colors, better adapted for agricultural purposes; and, indeed, there are those which are generally preferred to the black horse as possessing greater activity and cleaner limbs, combined with equal compactness and strength.

The dray-horse is reared in the greatest perfection in the richest pastures of the fens of Lincolnshire, the largest being seldom less than seventeen hands high, when two and a half years old, at which age, they are usually sold. The purchasers work them moderately until they are four years old, feeding them well during this period. Previous to their re-sale, they are often taken out of work and fat-

tened in loose boxes, much after the manner of oxen for the shambles, in which state they are supposed to please the eye of the London brewers, for whose more particular use these pampered animals are generally bred ; and a colt, for instance, perhaps purchased for $200, realizes in the course of two years double this amount, besides working moderately during the time. Thus the horse, if he does not fall a victim to the various diseases which the redundancy of fat is calculated to induce, yields an ample profit to his feeder. These noble looking animals, with round, fat carcasses, and sleek, glossy coats, are slow in their movements, and are not the best for hard and long-continued work ; but their proud deportment is well adapted to gratify the ambition of the brewer to outvie his neighbor; and as they move majestically through the streets of the metropolis, they present one of the most striking sights to the eye of the stranger. That such large massive animals are really required, or are the most profitable for their peculiar work, is a matter of considerable doubt. It is a species of pride, however, which has long prevailed among the London brewers ; and whilst they continue the premium in the shape of high prices, the breeding of them will remain a profitable pursuit, and the streets of that metropolis will doubtless exhibit the largest horses in the world. One great drawback attending this breed is their tendency to weak and convex feet and to ossifications of the cartilages and pasterns, the former being the effect of their great weight acting on the soft horn induced by moist pastures, and the latter to their great predisposition to throw out bone, caused, probably, partly by the large amount of phosphates contained in the grain upon which they are fed. Many of these horses are rendered useless from such morbid deposits, although the latter is so common that there is scarcely a dray-horse in London but has in some degree these "side bones," which, in many cases, do no injury. In the improvement of this breed, however, it should be an object to diminish, or rather to discourage, as much as possible, these objectionable qualities to which it is naturally so prone. When, therefore, it is considered that a heavy dray-horse, working in the shafts, with a load, perhaps, of four or five tons behind him, which, in turning a corner, devolves on him alone, and, in the act of walking, must be thrown alternately on each hock, the importance of having this joint free from disease and all tendency to it must be apparent.

That an animal of such huge dimensions as the English dray-horse should be profitable or adapted to American use, there are many doubts. The cost of their food, and the expenses attending the wear and tear of their trappings and shoes, are much greater than of any other horse. It is believed by some that he could be employed with advantage in the crowded streets of our larger cities, where it is difficult for ordinary drays to travel faster than a common walk, even with a light load. Take the lower part of Broadway, in New York, for instance, where it ordinarily requires thirty minutes to pass from the Battery to Chambers street with a load of half a ton, drawn by a single horse. By the London dray, the ground could be travelled over in about the same length of time, with at least five times that

weight, with but little additional expense, except the extra food consumed by the large horse over the one in common use. Similar reasons would apply to other parts of the United States.

But the horse which would seem to be best adapted for many agricultural purposes in this country, and one that possesses the combination of strength, compactness, and activity, is the "Suffolk Punch." It is difficult to trace the origin of this breed, other than that it has been reared in Suffolk for many years, where it was probably once employed for other purposes. These animals, for the most part, are of a chestnut color, though sometimes sorrel and bay, which uniformity shows that the breed has been kept tolerably pure. They are distinguished by roundness of barrel and compactness of form, generally combined with great activity. They are exceedingly staunch to the collar, free from any redundancy of hair on the legs, and are by no means coarse about the head. They are rarely of large size, but usually range from fifteen to sixteen hands high. It speaks highly in favor of this breed that, at the late shows of the Royal Agricultural Society of England, they carried away the majority of prizes. It should be observed, however, that they are rather more liable to strains of the sinews and the joints than most other breeds.

D. J. B.

ADAPTATION OF THE MOUNTAIN REGIONS OF THE SOUTH TO SHEEP HUSBANDRY.

BY GEORGE C. PATTERSON, OF ROGERSVILLE, HAWKINS COUNTY, TENNESSEE.

The opinion, which has heretofore generally prevailed, that the northern portions of the United States are better adapted to the purposes of sheep-farming than the southern, is gradually being removed by successful experiments, showing not only that this impression is founded in error, but establishing, conclusively, the converse of the proposition; that is, that, in all the essentials for profitable sheep-farming, a large portion of the Southern States possesses advantages incomparably superior to those presented by territory further north.

Beginning at or near a point on the 39th degree of north latitude, 150 miles from the Atlantic coast, and proceeding in a southwestward direction, as far down as the 34th degree, we find an expanse of country embracing about 180,000 square miles, the geological and climatological characteristics of which give to it advantages for sheep husbandry unequalled in any other portion of the United States, of the same extent.

This area of, say, 600 miles in length by 300 in width, includes large portions of Virginia and Tennessee, with considerable parts of Kentucky, North Carolina, Georgia, and Alabama, and a small portion of South Carolina and Mississippi.

The natural configuration of this vast region is not the least of the many desirable advantages it presents. It is situated many hundred feet above tide-water, fanned by the purest atmosphere, and supplied with innumerable salubrious streams. Having a high and dry range, so conducive to the healthfulness of sheep, and presenting a succession of mountain and valley, it affords the most ample defence against the heat of summer, as well as the bleak winds of winter. Artificial protection, indispensable at the North, yet so apt to induce disease, is thus rendered unnecessary in this more favored situation.

These valleys, or mountain gorges, are most prolific in a variety of herbage suitable for sheep, and, during winter, they afford a supply of pasturage so abundant that very little additional food is required. Especially is this the case when a portion of the range is reserved for the winter season, which is the proper course. Hence, the sheep have access to a continuous supply of green food, by which the secretory organs are retained in full action, and an uninterrupted growth of wool is promoted; while cases of constipation, frequently fatal at the North, by reason of sudden changes from green to dry food, are unknown here, there being scarcely a day in the year in which sheep cannot find sufficient green food to keep their digestive organs in healthy condition.

Many of the more elevated portions of this region are so naturally disposed to grass that it is only necessary to clear out the under-growth—which can be done at an expense of about $2 per acre—when the indigenous grasses, such as Timothy, blue-grass, white clover, &c., will immediately spring up and take possession of the land. There are few ranges of any extent that do not furnish ample quantities of arable land for all the purposes of the sheep-farmer; and they frequently include a fair proportion of excellent meadow land. The soil in this region is generally good, and it is by no means uncommon to find it fertile even to the tops of the mountains; and although there are to be found considerable bodies of thin soil, yet even these are more disposed to the production of grass than lands of a better quality further south.

This thin soil is generally of loose texture, and, therefore, liable to be washed off by rains, unless appropriated to grass. The common sedge is the kind usually found upon it. When this is burned off, in early spring, a luxuriant range is afforded for sheep during the summer. It is not advisable precipitately to substitute the cultivated grasses on this land, since it is not capable of growing them successfully. By burning off the dry and decaying growth of the previous year, when its accumulation interferes with a succeeding growth, and close depasturing for a few years, the sedge will gradually give way to the more valuable grasses. It is well known to all sheep-farmers that, when lands are freely pastured by sheep, their capacity for producing grass is much assisted, as by close grazing the more useless grasses, briars, &c., are subdued, and the desirable descriptions allowed to strengthen their hold, and this, together with the tramping of the land and the droppings of the sheep, induces a more dense sward.

The "Randall Grass"—said to have been discovered in one of the western counties of Virginia—promises to be the most valuable for sheep-grazing in the regions spoken of. From the many experiments resulting from the distribution of the seeds of this grass through much of Virginia and Tennessee, it seems to have met with universal favor. In character and growth, it closely resembles orchard-grass, but is more tenacious of life, flourishing under the most unfavorable treatment, and resisting the intrusion of sedge and other inferior grasses. It has a more profuse foliage than the orchard-grass, and a more slender and soft stem; it will retain its green color during the severest weather of winter, and exhibit an earlier growth in the spring than other grasses known in this region.

A comparative statement of the expense of maintaining sheep at the North and in this Southern country will exhibit the decided superiority of the latter, and materially assist us in forming correct conclusions. If we examine the various communications on this subject, contained in the Agricultural Reports of the Patent Office, we shall find the average expense of wintering sheep at the North to be about $1 25 per head, while in the region herein treated of it does not exceed 25 cents, or one-fifth the above amount; and in most winters, when the snow does not lie more than a day or two at a time, the cost of wintering is hardly worth computing. This difference in the expense of maintaining a flock is considerably widened when we contrast the value of lands in the respective districts. Those at the North, we may safely place at an average price of $20 per acre, while in the Southern region any quantity of lands suitable for sheep-walks can be purchased at an average of $1, and many large tracts at half that price, or even less; thus affording decided advantages to persons of small capital.

That the climate of the Northern States is more favorable to the growth of fine wool than the region to which I refer, repeated experiments are disproving. Although it is an admitted law of Nature that the covering of an animal will adapt itself in a great degree to the climate in which it abides, yet this does not prove that fine wool cannot be grown in a warm climate any more than that fine furs or fine feathers cannot be found there; for many animals, bearing the finest quality of furs, inhabit the most southern borders of our country, such as the beaver, otter, muskrat, and flying squirrel, and may be classed among the finest fur-producing animals; they are all found in Texas, as well as in the Canadas. The Merino sheep has been bred for ages as far south as the 36th degree of north latitude, in Asia; and we are informed by eminent writers on the subject that there is no perceptible difference in the fineness of their fleece from that of the flocks of Europe; and we have the testimony of the head of the great Lowell Manufacturing Company, who has purchased extensively from all parts of the United States, that "wherever there are good shepherds there is sure to be found good wool." The veritable samples of wool grown by an eminent sheep-farmer of Tennessee, (Mr. Cockrill,) are said to have exceeded in fineness those selected by an agent of our government from the best flocks of Europe; and this gentleman

attributes its superior quality to the climate of that region, although it was grown nearly two degrees south of the scope of country of which I am treating, and not in the true grass region. Whether Mr. Cockrill is correct or not in his opinion, the fact is incontrovertible that the climate has worked no deterioration in the quality of the wool in the many years he has given wool-growing his attention. But whatever difference of opinion may exist on this subject, it is established beyond doubt that wool grown in a warm climate has a longer and softer fibre than that produced in the colder countries, although there may be no difference in the fineness of either; and the manufacturer will give a decided preference to the longer and softer staple.

Since the introduction of the Saxon sheep at the North, it is found that they are not capable of resisting the severity of that climate, and the breeding of them is abandoned as unprofitable; but it is reasonable to conclude that this most valuable variety of fine-woolled sheep, before long, will find its fixed place of habitation in the more congenial climate of the South.

There are but few wolves in this region, and as they commit their depredations only at night, all danger from them may be obviated by penning the flocks at such time, when they will also be secure from the attacks of curs, which are unfortunately but too plentiful in this wild and uncultivated region.

REPORT ON ASIATIC GOATS.

By a resolution of the Southern Central Agricultural Association of Georgia, a committee was appointed to report on the goats now in the possession of Mr. Richard Peters, of Atlanta; and, in compliance therewith, presented, through Dr. John Bachman, of Charleston, South Carolina, their chairman, an elaborate report, from which the following is an abstract:

Among all the domesticated animals introduced into our country, the goat has hitherto been regarded as the least valuable. The several large breeds, such as the Scind, the Maltese, and the Swiss goats, which were, from time to time, introduced as milking animals, were, after a period, neglected and considered as of no great value in comparison with the cow; and we are not aware that their milk is converted into cheese in any portion of our country. The hair was too coarse for manufacturing purposes, and the flesh was considered inferior to that of veal or mutton; hence the goat was scarcely regarded as deserving of notice among the herds of the farmer. The wisdom of Providence has, however, so ordered it that, in all the species of animals intended for the use of man, distinct and permanent varieties are produced in different localities, which varieties, by proper attention, may be preserved for ages without change or deterioration. Breeds of horses have been produced, adapted to the various necessities of man. The breeds which have originated from our domesticated horned cattle are equally varied, and so organized

as to minister to the wants of man in the different climates of the world. The sheep, which, in many of its varieties, is a coarse-woolled animal, has assumed various forms and infinite varieties in the flavor of its mutton—in its fleece, and in its adaptation either to cold, temperate, or tropical climates. In Africa and the West Indies, breeds have sprung up, called by some "Nubian sheep," the wool of which has become converted into a short, coarse, glossy hair. In the mountains of Spain and in Saxony, varieties of the same species produce the finest wool. These Merino and Saxon sheep having become permanent breeds, have retained their fine fleece in our country during successive generations. The varieties of the goat are equally numerous and equally varied in different countries. They are all of one species, the varieties mixing and multiplying with each other *ad infinitum.* They all claim as their origin the common goat, *(Capra hircus,)* which, it is admitted by nearly all reliable naturalists, derives its parentage from the wild goat, *(Capra œgagrus,)* that still exists on the European Alps. Two individuals of this wild species lived for several years in the menagerie of Paris, and exhibited all the habits of the common goat. We have, on several occasions, seen herds of our common goat, which had strayed away and become wild ; one of these might for several years have been seen on that wonderful production of Nature, the Stone Mountain of Georgia. They evidenced all the peculiarities ascribed to the wild goats of the Alps. A herd of these goats exists on the precipitous side of Ben Nevis, in Scotland, and are described as still numerous on the rocky island of Juan Fernandez, which the fertile imagination of Defoe, by the aid of the narrative of Selkirk, has invested with such a fascinating romance.

An animal so easily reared and domesticated must have been given to man by a beneficent Providence for a more valuable purpose than that of its very sparing portion of milk and its rather inferior flesh. The Creator, who gave to our first parents the soil, with the command to "till" it, has also given to the animals which accompany him in his migrations over the earth an organization adapted to the production of improved and permanent varieties. These, when produced, it becomes the duty of man to increase and multiply. The individual who does this, by the application of his time, his scientific knowledge, his labors, or his wealth, carries out the designs of a superintending Providence, and becomes a public benefactor. The goat has, in several of its varieties, become a wool-bearing animal. To these we will now direct our attention. We have satisfactory evidences that, from the time of Moses, who in several places refers to the fine linen and goat's hair spun by the women, the manufacture of fine fabrics from the hair of this animal has been uninterruptedly kept up. Throughout all the higher mountains of Eastern Europe and Western Asia, goat's hair, of fine quality, has been an article of manufacture and a source of wealth to thousands of the human family. These fine-haired breeds of goats exist under many varieties in Angora, Northern Persia, Cashmere, Nepal, Thibet, &c. These have sent off herds, varying in some particulars, into Bucharia, Tartary, and Syria. A small herd was, some years ago, after incalculable difficulties, carried

into France, from whence a few found their way into England, and we have now another variety in our own country derived from the same Eastern source. Hodgson describes four varieties of goats as existing in Nepal and Thibet. The "Shawl goat" he calls *Changra*, and the Cashmere of Cuvier is called by the natives *Chappoo.* The Shawl goats are characterized as being "covered with long silky hair, with an under vest of delicate greyish wool." The quantity of this wool is very small, not exceeding two, or at furthest three ounces. The Angora goat derives its name from the country where this peculiar variety has originated. It is remarkable that nearly all the domesticated animals carried to Angora have, in the course of time, produced varieties, the whole pelage of which is formed of white hair of uncommon length and fineness. Not only the goat has thus been changed, but also the sheep, cats, rabbits, &c. Neither the latitude, the altitude, nor calcareous soil of this country are in themselves sufficient to account for these remarkable transformations, since there are more northern regions and far higher mountains in other countries, with chalky marl formations, where this peculiarity does not occur. The Angora goat, more especially the varieties it has produced, is described by Hassilquist, Buffon, Pennant, and others, as in general of a beautiful milk-white color, with short legs, and black, spreading, spirally-twisted horns. The hair on the whole body is disposed in long pendant spiral ringlets; its ears are pendulous, and the horns of the female, instead of divaricating, as in the male, turn backward, and are much shorter in proportion.

Professor Lowe, in speaking of the climate in which the wool-bearing goats are produced, characterizes it as "stretching from the mountains of Thibet into the elevated Steppes of the interior, northward to the arctic regions, eastward through Chinese Tartary, and westward through the vast dominions of Russia to the confines of Europe. In the northern provinces of China, there are goats of a small size, which yield wool as abundantly as the sheep of the same country. Extending over the varied surface of Hindustan, the goats assume a prodigious diversity of color, aspect, and form. Sometimes they have horns, and sometimes they are destitute of them; sometimes they have long pendulous ears; sometimes they have a short fur, like that of a fawn, and sometimes fine silky hair falling in glossy ringlets on each side of the dorsal line. The largest of the goats of Hindustan are brought from Cabul, Thibet, and the highlands of Persia." The varieties in form, color, and qualities of pelage, under which these various breeds of goats are presented, will account for the great difference in the figures of what are called Cashmere goats. The same may be said of the Thibet shawl and the Angora goats. In a word, they are all of one species, but under many varieties; breeds have become permanent, and some are infinitely more valuable than others. Local names have been attached to these various breeds, many of which are still confined to the herdsmen of the East. To the farmer the possession of the most valuable breed of goats is of far more importance than the name by which it is designated.

Since, however, we are obliged to regard the different breeds of animals by the names under which they are usually designated, we are not allowed to consider the goats of Mr. Peters as the true Cashmere. The two kinds of hair, with an under vest of delicate greyish wool, which amounts only to two or three ounces on a well-grown animal, together with horns not spiral, draw a broad line of separation between these probable crosses and the far superior goats of Mr. Peters. This animal differs also from the Angora goat, to which it has a nearer approach, and from which this improved variety has probably descended. In the few specimens of the Angora, which we saw many years ago in Europe, and in the figures now extant of this variety, the ears, compared with those of the goats of Mr. Peters were smaller and less pendulous ; the tail much longer ; the neck covered with a mane of almost straight hair, reaching the shoulders, and uniting with the beard under the chin ; the body was larger and more goat-like, and had less the appearance of a sheep than the present variety. The fleece was equally white and glossy, but more than twice as coarse. By what local name this breed of goats, owned by Mr. Peters is called in the East, remains for some future naturalist or traveller to determine. It will probably be found among some of the varieties spoken of by Hodgson and other travellers, who have given very imperfect descriptions of the varieties existing in the hilly regions of Nepal and Thibet, but who say of them: "One character they all have in common—pendent or semi-pendent ears, more or less prolonged, and in all the hair falls in long masses, sometimes twisted into spiral ringlets."

We have adopted the usual rule among naturalists in designating animals by the common names under which they were sent, leaving it to time and further observation to determine their true place in science. Hence, we have continued the name under which it was imported, which may have been Cashmere in one of the languages of the East, as it is a general term—the name of a country which is known to possess several distinct varieties, both of the goat and sheep. At present, we can only designate them by the general term "Asiatic Goats," or, to be more definite, as the "Davis Cashmere Goats," from the individual who introduced them.

It yet remains for us to consider the most important subject connected with this report. What benefit may our country be expected to derive from this breed of goats? They were introduced into South Carolina, in 1849, having been brought from Turkey, in Asia, by J. B. Davis, M. D. We examined these animals on their first arrival, and pronounced them as destined to become a valuable acquisition to our country. We have since taken advantage of many opportunities, from time to time, of ascertaining their adaptedness to our climate, and saw them recently at the farm of Mr. Peters, at Calhoun. We are much gratified in stating that the proof has far exceeded our most sanguine expectations. We will give the result of our inquiries and experience under several heads.

CONSTITUTIONAL CHARACTERISTICS AND ADAPTEDNESS TO OUR CLIMATE.

These goats appear to be remarkably well adapted to our climate, show no evidence of suffering, and do not pant like sheep during the warm weather of summer, when the thermometer often rises to 92° F. In winter, when the thermometer sometimes sinks to zero, their woolly covering protects them from the cold, which they endure fully as well as sheep. In the lower country of Carolina, during recent severe winters, we ascertained that many of the common goats (as far as we could learn, one-half of the whole stock) perished from cold; the Asiatic goats, however, did not appear to suffer the least inconvenience. Kids were dropped in a snow bank, at Mr. Peters' farm, in February, and sustained no injury. Three of these goats were kept during winter and summer near Utica, in Central New York, and three others, with their descendants, have remained near Harper's Ferry, Virginia, since the autumn of 1854; all of them are doing well, and have suffered no inconvenience either in winter or summer. This hardy disposition is imparted to the different grades, the half and three-quarter bloods, produced by an intermixture with the common goat. They are all healthy. No disease has appeared among them, and there has not been a single sick goat or any death by disease among those originally imported, or in any of their descendants, during the eight years since their introduction.

The oldest imported female is at least ten, probably eleven, years old—produces a kid every year, and now has at her side a very fine female, dropped on the 10th of March last. She is in fine order, and looks as though she would breed for several years. The females furnish an abundant supply of milk, and are excellent mothers, never losing their kids, which are strong when dropped, and able to suck in a few moments, the mother remaining over and about them for forty-eight hours, and afterwards always keeping a careful watch. The half-breed ewes inherit from the Davis goats this peculiar trait of character, being the very reverse of the common goats in this particular, the latter, especially when bred in large herds, care little for their young, which are often left to die for want of nourishment when a few hours old.

INCREASE.

This has been less than was at first anticipated. The fact of the common goat having two, and, sometimes, three young at a birth, and often two broods in a year, led many persons to the conclusion that this new variety of goat would be equally prolific. In this, experience has now undeceived us. The animal produces young but once in a year, and only one kid at a birth. Mr. Peters received from Dr. Davis, in December, 1856, eight females and two males—three of the females having been imported. There were in this number

three small kids which failed to breed until two years old. From these females, Mr. Peters has raised twenty-one, twelve of which proved to be males and nine females. Thus it appears that the constitution of this variety is organized like that of the wild goats, (*Capra œgagrus*,) which produces but one young annually. As, however, it produces young when fifteen months old, and continues to breed until over ten years of age, taking into consideration the strength and hardihood of the kids, we may safely consider it as equal to the French Merino sheep in the rapidity with which a flock may be bred and increased.

PREPONDERANCE OF YOUNG MALES OVER FEMALES.

It has frequently been remarked, that animals and poultry of various kinds brought from China and Western Asia produce a much greater number of males than females. The only experiment we made was on the Shanghae fowl, which, as long as we had an old male, produced, on an average, three or four male chickens to one female. Since we have kept young males only, the sexes in their descendants are about equal. It was at one time feared that the experiments in the introduction of these goats would be greatly retarded from the fact that they produced nearly all males. In 1854, Dr. Davis used one two-year old buck to five ewes. The result was two females and three males. In 1855, Mr. Peters used the old imported buck to eight ewes ; the result was, two females and six males. In 1856, he used a buck kid of nine months old to six ewes ; the result was, four females to two males. In the same year, he used the imported buck to two ewes ; the product was one male and one female. It will be a matter of interest to the physiologist to become acquainted with the result of a further continuance of these experiments.

FOOD.

Like all species and varieties of goats, these animals prefer weeds, briars, and leaves to grass. Mr. Peters informed us that, during the summer months, they are a decided benefit to his grass-lands, by feeding on, and finally destroying, briars, weeds, and bushes. They are especially fond of the leaves of young pines and cedars, both in summer and winter, the balsamic character of which is conducive to their health and thrift. During winter, they should be fed like sheep, but do not require much attention, except in snowy weather, as they are better able to shift for themselves. Mr. Peters advises that during this season they should be divided into flocks of about one hundred, or less, as they butt each other at feeding time.

THE FLESH AS AN ARTICLE OF FOOD.

We have never indulged in the extravagant luxury of feasting on a full-blooded animal of this variety ; but we have, on several occasions, made a hearty meal on the quarter, half, or three-quarter

bloods, and all who dined in company pronounced the meat of the half-breed wethers superior to lamb, and at eighteen months old, superior to mutton; the flavor approaches nearer to venison than to mutton. They remain fat nearly throughout the year, and in November are almost too fat for the table. We observed a great improvement in the progeny of the full bloods over their imported parents, both in fatness and size. The weight of the buck is given as 155 pounds; that of the doe 102 pounds.

LIABILITY TO BE DESTROYED BY DOGS.

If this animal were as liable to be killed by dogs as the common sheep, we would tremble for the perpetuity of the race in our country. A flock of sheep when pursued by dogs scatter in every direction, and fall an easy prey to their relentless blood-thirsty foe; but when he approaches a herd of goats, he finds them formed into a ring—the kids in the centre and the old bucks in advance—exhibiting their formidable horns. No dog is bold enough to close in, but usually runs, barking, around them, thus attracting attention, and receiving the reward of his carnivorous designs. Mr. Peters informs us that he gave up the raising of sheep after having a dozen fine South-Downs killed by a pack of dogs, when they also destroyed four common ewe goats; but since there were no sheep on the farm, to tempt the dogs, they have not come near. He says that he has lost none of his goats, either of the pure breeds or the grades, by dogs. He further remarks that with a large herd he had no trouble. They have a range of two or three miles over fields and through woods; they return every evening before sunset to their house, and in case of a shower of rain, run to their shelter, even at the distance of several miles. He believes that a thousand or more would continue in fine condition, during summer and fall, in one flock, on a large range, as they are free from disease, do not crowd together like sheep, or suffer from heat; they are very easily driven and managed, and do not run off and get lost.

FLEECE.

The quantity sheared in April was, from the aged bucks, from 5 to 7 pounds, and from the ewes from 4 to 5 pounds. Mr. Peters shears but once a year, but intends hereafter to clip the kids in September and again in April.

In regard to the fineness of the fleece, we find a microscopic examination of the hair of Asiatic goats, from the stock now owned by Mr. Peters, William P. Davenport, of Virginia, and Dr. Ambler, then of New York, printed in the Agricultural Report of the Patent Office for 1855. The examinations were made by George C. Schaeffer, M. D. He says, "the degree of fineness is about that of the finest Saxony wool." He gave also an outline from a "piece of shawl stuff imported from Calcutta, and said to be the finest ever brought into this country." He adds, "it is gratifying, then, to be assured that the

fleece may be raised in this country with a fineness closely approximating to that which it has ever attained in Asia under the most favorable circumstances." We have lying before us specimens from the fleeces of several young Asiatic goats, which we have compared with the finest wool of the Merino sheep, and find the former not only equal in fineness, but of far greater length. It must, however, be observed that young animals, at their first shearing only, present this remarkably fine fleece. In the old female, it is a little coarser, and in the old males still more so. It is proposed by Mr. Peters to divide the fleeces of these goats at shearing-time into classes, thus:

Kids under a year old	No. 1.
Yearling ewes and yearling wethers	No. 2.
Yearling bucks, old ewes	No. 3.
Aged bucks	No. 4.

The fleeces of old ewes and yearling bucks would answer for cloth of a valuable texture. The fleece of the yearling is much finer than that of the old ewes; and that of the kid is fine enough for the very finest shawls, and ought to be very valuable. There is a large class of fabrics for which these fleeces are peculiarly adapted, namely, camlet and worsted goods and ladies' fabrics, as shallies, mouslin-de-laine, gentlemen's clothing for summer wear, hosiery, &c., promising a beauty, strength, durability, lustre, and permanency of color, far superior to the wool of the alpaca or sheep. The goats' hair is known to receive and retain the most brilliant coloring, which the hair of the sheep and the alpaca has not the property of retaining.

RESULTS OF BREEDING WITH THE COMMON GOAT.

Familiar as we have been through a long life with the changes produced by crosses among varieties of domestic animals and poultry, there is one trait in these goats which is more strongly developed than in any other variety that we have ever known. We allude to the wonderful facility with which the young of the cross between the male of the Asiatic goat and the female of the common goat assumes all the characteristics of the former. It is exceedingly difficult to change a breed that has become permanent in any of our domestic varieties, whether it be that of horses, cattle, sheep, or hogs, into another variety by the aid of the male of the latter. There is a tendency to run back into their original varieties; hence the objection to mixed breeds. But in the progeny of these Asiatic and common goats, nine-tenths of them exhibit the strongest tendency to adopt the characteristics of the male, and to elevate themselves into the higher and nobler grade, as if ashamed of their coarse, dingy hair and musky aromatics, and desirous of washing out the odorous perfume, and putting on the white livery of a more respectable race.

Mr. Peters has not bred any quarter-breeds. He made wethers of all his half-breed males, of 1856, and sold his three-quarter blood bucks. He now owns one hundred and fifty half-blood females,

seventy-five three-quarter blood females, and six seven-eighths blood females. He has also four females three-quarters Asiatic and one-quarter Thibet shawl. There appears to be no improvement in this mixture with the Shawl goat, over that produced by a union with the common goat; indeed, the product which we saw in Charleston, from what was called the Cashmere and the Asiatic goat, was decidedly inferior.

The half-bloods, as we have stated, have an under-coat of fine, downy wool, closely resembling and equal in quality and quantity to the fleece of the Thibet Shawl goats imported into this country. The three-quarter breeds in mid-winter show an under-coat of greater quantity and length. In both grades, this under-fur drops out in summer. The fifteen-sixteenths or one-sixteenth common goat resembles the Asiatic goat in quantity and quality of fleece and size of carcass, so closely that we found it impossible to distinguish them from the full-bloods. Another advantage is likely to result from this admixture with the common goat: the half-blood females produce two kids at a birth, and the three-quarter blood females generally, although not always, two. Thus the breed may be rendered more prolific. We here perceive in how short a period of time our whole race of now almost worthless goats may be converted into a breed valuable both for its flesh and wool.

REGIONS OF COUNTRY TO WHICH THEY ARE BEST ADAPTED

There does not appear to be any part of the United States to which the constitution of this goat is not adapted. Damp climates, like England, where there are almost daily drizzling rains, are injurious. This animal scarcely needs water. We were informed by Mr. Peters that three of them remained in a lot, feeding on weeds and grass, without any water, during three months, and keeping in fine order. Our whole country is warm in summer, and portions of it very cold in winter. If this goat is constitutionally adapted to brave the cold of the Steppes of the Eastern Caucassian, Himalaya, and Altaian Mountains, it would not suffer, if fed in winter, in our coldest regions, and would thrive along all the sides of the Alleghany and Rocky mountains. It has improved in the comparatively warm climate of Carolina. It would do well in the hilly country of the Carolinas and Georgia, many portions of which are now scarcely cultivated. The whole western country, from Nebraska down to Western Texas and New Mexico, may be rendered a feeding-ground for this wool-bearing goat. The mountain regions of Virginia, North Carolina, Kentucky, and Tennessee will be found admirably adapted to the raising of large flocks of these goats and their crosses. The wild growth of the mountain-sides, with the native grasses of the rich valleys will afford pasturage summer and winter at a trifling cost. The worn-out plantations and poor pine lands of the Carolinas and Georgia might be brought into requisition to supply meat for our markets, which, by many persons, would be preferred to venison. A

single shepherd could guard a flock of several thousands, more especially if he called to his assistance the large shepherd-dog from the Swiss mountains. They would not only astonish the marauding wolf, but his prowling relative, the cur. It is not impossible that, among the many varieties of goats existing in the far distant and almost inaccessible regions of the Eastern World, some breeds may yet be found more valuable to our country than this; but at present, we know of none that can be compared with it.

WHAT IMPROVEMENT CAN BE MADE IN THIS BREED OF GOATS?

Since it possesses the characteristics of all the other domesticated animals, we have reason to believe that, by judicious breeding, and devoting to this subject the same attention that breeders in England bestow on their horses, cattle, sheep, and swine, an equal number of improved varieties will be produced. We are at present unacquainted with any superior variety of goat with which this might be crossed to improve the fineness of the wool. Improved individuals, however, spring up in these varieties themselves, without any foreign admixture; and by selecting these, and separating them from the common stock, we have at once a new breed, which soon becomes a permanent race. Let us in these matters follow the teachings of Nature in all her departments. How were the varieties of Sea Island cotton, of large rice, of prolific corn, wheat, &c., produced? A few stalks of these superior qualities were detected in the fields. Thus far it was the free gift of a beneficent Creator. Man, his agent, now selected and cultivated them separate from all others. Thus a valuable variety was obtained that may, by proper care, be perpetuated. In the *Courrier des Etats Unis* we have a long and interesting account of a Merino sheep in France, which, instead of wool, produced fine silken hair. The breed was perpetuated, and goes under the name of "Cashmere sheep." At the "Universal Exhibition," in Paris, it was affirmed by the judges of one of the shawls made from this hair, that "they found this (as they named it) native Cashmere as soft and as brilliant as the imported, and that it was superior to the latter on account of its regularity of detail."

CONCLUSION

In conclusion, we may be asked, whether we are induced to believe that, from the many good properties of this goat, it will eventually supersede the sheep in husbandry? We answer, certainly not. A gift of Providence so valuable as the sheep is not to be cast aside by any intruder on its rightful domains. The sheep and the goat have each their appropriate sphere in the economy of Nature, and there are good properties in each that cannot be supplanted by the other. The Creator, in his munificent benevolence, has given a limited number of valuable domestic animals and poultry, grains, fruits, and vegetables to man, all capable of producing varieties, and of accompanying him in his migrations over the world. Each has its limits

of usefulness, and one species cannot intrude on the rights of the other. The maple tree of the North, and the sugar beet and Chinese sugar cane of more temperate climates, are admirable substitutes, and of immense value. They are also well adapted to check the cupidity of speculators in sirups and sugars; but they cannot in the end demolish the great sweetner of the human palate of the world—the old tropical cane. Cotton is at this time king, and is struggling, like Aaron's rod, to swallow up all the lesser products of silk, flax, and wool, but they are destined still to hold their place in the articles that minister to man's comfort. The sheep will not be depressed in the scale of man's valuable commodities; the goat will only be elevated to the standard to which it was designed to rise. Thus each product revolves in its own sphere like the lesser lights in the firmament, reflecting glory on their great Author, and conferring benefits and blessings on him "who was created in his image, and crowned with glory and honor."

THE LLAMA AND ALPACA—THEIR GEOGRAPHICAL DISTRIBUTION, ORGANIZATION, FOOD, HABITS, AND PROBABLE ADAPTATION TO CERTAIN REGIONS OF THE UNITED STATES.

On the lofty Cordilleras of the Andes, in South America, considerably below the line of perpetual snow, from Chili nearly to the equator, there abound at least three kinds of animals known under the names of "Guanaco," or "Llama," "Paco," or "Alpaca," and the Vicuña, the latter of which, according to the classification of Cuvier, is merely a variety of the llama. This also agrees with the opinion of Inca Garcilaso de la Vega, who says, in the year 1811, that "the domestic animals of the Peruvians are of two kinds—the greater and the smaller—which they, as a common name, call *llama;* that is, cattle or sheep. The larger kind they call *huanacu-llama*, on account of the resemblance it bears to the wild animal known in Peru by the name of *huanacu*, from which it differs only in color; for the domestic llamas are to be met with as various in their colors as horses; but the wild llamas are uniformly of a chestnut color. The larger kind bears a great similitude to a camel, except that it is deficient in the hump upon its back, and is not so large. The small kind they call *paco-llama*, which is only reared for its flesh and wool. The *vicuñas* are not very unlike goats in their appearance, except that they have no horns, are larger, and are of a leonine color, or more ruddy. They live in the highest mountains and groves, and particularly love those cold regions of solitude, which the Peruvians designate by the common name of *punas;* neither are they annoyed by frost and snow, but are rather created by them. They go in flocks and run most swiftly; and such is their timidity that, at the sight of man or wild beasts, they instantly hurry into inaccessible retreats, and thereby elude their pursuits. There were formerly a

great number of these animals here, but they are now become much more rare in consequence of the promiscuous license of hunting them. Their wool is very fine, resembling silk or the fur of the beaver, and the natives deservedly hold it in high estimation; for, besides other properties, it is also said to resist heat and impart coolness to the wearer."

The llama, *(Auchenia glama,)* ordinarily, is from 4 to 5 feet in height, of a light-brown color on the back and sides, and under the belly uniformly white. Sometimes, however, it is dun, grey, or even inclining to purple, and very seldom parti-colored or black. The hair is long, of a texture between silk and wool, but not curled.

The alpaca *(Auchenia alpaca)* is smaller than the llama, its usual height being only 4 feet. It appears more corpulent, however, owing to its possessing a much longer and a more profuse clothing of hair, which, sometimes, is from 8 to 12 inches in length on the sides, rump, and breast. The fleece of an old individual is represented to weigh 20 or 30 pounds. It partakes of various colors, often being parti-colored, but more frequently white than the other species.

The most valuable breeds are said to come from the central provinces; and here it may not be irrelevant to observe that there are too varieties of alpaca, differing in size, figure, and fleece. The breed called *coyás* is the most diminutive, and is esteemed for the smallness of bone and symmetry of form. It is chiefly confined to the Cusco range of mountains. more particularly to that part of it intervening between the ancient city of the Incas and Haumanga. It is thought to be a remnant of the old royal flocks, or those once owned by the priests of the sun, who are represented as having the choicest breeds. That territory was, besides the principal theatre of agricultural operations, the seat of power, and the centre of Peruvian civilization.

The Peruvians dry the flesh of the llama as well as that of the alpaca, which they are very fond of eating.

The order to which the genus Auchenia belongs offers to the eye of the naturalist but a very small anatomical difference of conformation from that containing the camel, properly so called. The feet are not, like those of that quadruped, entirely padded with an elastic sole, but the two toes are separated, each having strong, horny nails, or hoofs, nearly resembling the talons of a bird, with a thick cushion, or pad beneath. These animals are also dissimilar in the formation and arrangement of their teeth, having on each side of the upper jaw one canine tooth more than the camel, but are deficient in a second canine tooth in the lower jaw. Their incisors project fully half an inch from the muzzle-bone, so as to meet the pad fitted above, by which means, and with the aid of the tongue and cleft lip, they are not only enabled to draw together and clip short grass upon the ground, but also, with their long necks, pointed muzzles, and the oblique posture which the head can assume, to collect herbage growing on the hedges, and in the interstices of rocks 7 feet high, as well as the tops of hedges and tall shrubs. Their teeth are, at the same time, so strong,

and interlock in such a manner that they easily crush and masticate vegetable substances too hard and tough for ordinary cattle. The absence of the hump and of the callosity on the breast, also constitute striking points of difference between these animals and the camel. The llama, however, has a conformation resembling the camel's hump, being provided with an excess of nutritive matter, which lies in a thick bed of fat under the skin, and is absorbed as a compensation for an occasional want of food. Some of these animals, as in the camel, have callosities on the knees of the fore-legs, and, like them, kneel down in the same manner. Their stomachs and those of the camel, in some respects, are similarly organized. That of the llama, according to Sir Everard Home, has a portion of it, as it were, intended to resemble the reservoirs for water in the camel; but these have no depth, being only superficial cells, and have no muscular apparatus to close their mouths, and allow the solid food to pass into the fourth cavity, or digesting stomach, without going into these cells. But the stomachs of these quadrupeds certainly must have some kind of internal mechanism for retaining water or secreting a liquid substance; for it has been remarked, along the flanks of some parts of the Andes, that they live far above any lakes or streams, and abstain from drink a great portion of the year; and further, it has been observed that, in a state of domestication, they never manifest any desire to drink so long as they can obtain an abundance of succulent herbage. From the peculiar organization both of the camel and the llama, we are led to infer that each is evidently fitted by Nature for the endurance of great hardships and privations—the one amidst the sands of the desert, under a burning sun; the other on the wastes of some of the loftiest mountains of the globe, with a region of perpetual snow above. The slight variations of their conformation, such as that of the foot, are modifications of Nature which befit them for their respective abodes. A habitation amongst the rocks would be mechanically impossible for the dromedary, whilst the burning plains would be as little suited to the paco.

The llama, in its natural habitat on the Andes, at an elevation of from 8,000 to 12,000 feet above the level of the sea, far above any lakes or streams, feeds, through choice, on a sort of rushy grass, or reed, called *ichû*, which grows in abundance where it is said these animals are never known to drink so long as a sufficiency of green, succulent herbage can be obtained. They also derive subsistence from the mosses and lichens which fringe the rocks among their native haunts, or by browsing upon tender shrubs. They adapt themselves to almost any soil or situation, provided the heat is not oppressive or prolonged, and the air is pure, possessing a hardiness of constitution admirably well adapted to the nature of their birthplace, where, during half the year, snow and hail incessantly fall; whilst in the higher regions, nearly every night during summer, the mercury sinks below the freezing point, and the peaks are perpetually covered with accumulations of ice or snow. It is astonishing that the temperature of the air, on mountains so peculiarly situated and exposed to the full glare of the vertical sun, should be so much

chilled as almost to present the desolate aspect of the Arctic regions; and yet such are the tracts upon which the vicuña and the guanaco abound and run wild, far above the abode of man, and are hunted for their flesh and skins. It is remarkable, however, that they do not inhabit Quito, Santa Fé, Caracas, &c., although the climate of the mountains of those parts is similar to that of High Peru.

The comparatively small size of these animals, as well as the vegetable forms by which they are surrounded, clearly indicates that the climate of the Andes is not favorable either to animal or vegetable growth. It has also been remarked, that there the human species is subject to the same law; man decreasing in bulk and stature in proportion as he dwells near the mountain summits. In Peru, the winter sets in towards June, and is severely felt on the highlands, where the snow remains upon the ground six, and in some places eight months in the year. As soon as the narrow and green strip of land bordering upon the Pacific is passed, the traveller begins to ascend the slopes; and when he attains the first table-land, observes a complete change in the climate and the appearance of vegetation. Except in the *yungas*, or hollows, where an alluvial soil has been collected, and where the Indian plants his sugar-cane, banana, and esculent roots, the country wears a naked and barren aspect.

The female llama and alpaca go with young eleven or twelve months, and rarely produce more than one at a birth. They are weaned when half a year old, but are not put at work before they have completed the third year. They begin to bear when two years old.

The llama and alpaca, as well as the alpaca and vicuña, can be induced to breed together, and of the former union there are frequent instances to be met with in Europe as well as in Peru. From this alliance, a beautiful hybrid results, if possible, finer to the eye than either parent, and also more easily trained to work, but, like the mule, it does not procreate.

From the sterility of this hybridous race, it would follow that the alpaca is a distinct variety of the llama tribe, differing as much from its allied species as the horse does from the ass; and, consequently, that the two domestic animals of the Peruvians were not brought to their present state by means of crossing. Their intermixture is a modern expedient by the Spaniards. It is a rule of the vital economy, that life only springs from life, and every being is consequently endowed with the property of generating an offspring, inheriting a nature similar to its own. When the species vary, this rule ceases to act; whence, although possessing a strong physiological resemblance in many important points of their organization, there must necessarily be some material difference between the llama and alpaca in the functions of generation, which it is more than presumable equally extends to the wild species, and that difference produces an irregularity at variance with Nature's laws, constituting an essential condition of life. It appears from the report of M. Bory de Saint Vincent, a distinguished naturalist, who accompanied the French

army into Spain, under Marshall Soult, that he observed in the Zoological Garden of Don Francisco de Theran, at San Lucar de Barrameda, in Andalusia, three *alpa-vigonias*, (the cross between the vicuña and alpaca,) the fleeces of which were much longer, and six times heavier than those of any other variety. The Spaniards were proud of this acquisition. thinking that they had thereby obtained a new race of wool-bearing animals, calculated to people their hills and repair the loss sustained through the decline in their Merino flocks. By the experiment of crossing, however, they defeated the very object which they had in view, as the animals gradually died off without leaving any offspring, and in the course of a few years, there was scarcely one individual to be found in the kingdom.

The Peruvians are careful not to overload either of these animals, the burden of which is generally about 100 pounds, though, for a short distance, on good roads, they occasionally carry 12 or 15 pounds more. They are usually docile and willing to perform their task, if gently treated, but if provoked, they express their anger by turning back their ears, and spitting into the face of their offender, even if he be 3 or 4 yards off. Their food is never prepared for them, but when unemployed, they are suffered to graze on their native mountains, often pasturing in company with the wild species; but they are so much accustomed, and apparently attached to mankind, that they never exchange servitude for freedom. Those animals which have been brought to Europe and the United States appeared to thrive well for a time on the same sorts of food as eaten by cattle and sheep; but the inferior kinds of browse, grass, or hay, with a due proportion of potatoes, carrots, or other succulent roots, were preferred by them to rich pastures and farinaceous grains. Too liberal an allowance of nutritious and stimulating food to an animal extremely abstemious cannot, therefore, be regarded other than injurious. Its peculiarly formed stomach is not adapted to dry, hard food, the best proof of which is its habitual abstinence from drink. In Peru, the llama is sometimes treated with maize or millet in their green, soft, milky stage.

In regard to the diseases of these animals, it has frequently been remarked that, when they are taken down to the lowland towns, and are there kept for much length of time, they perspire freely, as soon as the hot weather comes on, and if neglected, a scurf, or rash, forms on the skin. In their new character, the coat, of course, is carefully preserved as being ornamental; but if it is shorn off, and the animal is bathed in the cool part of the day, before the system has been heated by exercise or the natural warmth of the climate, the sufferer invariably recovers in a short time. This cooling remedy, it has been observed. the animals themselves naturally seek; for, when taken down to the heated atmosphere of the plains, should this rash break out, both these animals instinctively go in search of a refreshing stream, not for the purpose of drinking, as has been erroneously supposed, but for bathing, and thereby preserving their health.

For a period of nearly forty years, the subject of introducing these quadrupeds into this country has been agitated, and several attempts

have been made to engraft them into our husbandry. As well known instances of this, it may be recollected that the late Colonel Skinner published an extended notice of these animals in the "American Farmer," in Baltimore, advocating their adoption, in 1821; the "American Agricultural Association," of the city of New York, raised a fund by subscription for the introduction, in 1846; a present of several of them was made by the Peruvian Government to the Honorable Daniel Webster, when Secretary of State; and the early part of the past winter, a cargo of llamas and alpacas were shipped to Baltimore, on speculation, from Guayaquil. But owing to the apparent inadaptability of these animals to the climate and elevation of the Atlantic and Gulf States, all the experiments hitherto made proved futile. To succeed, then, as a last resort, we have only to direct our attention to those vast elevated tracts known under the name of the "Great Plains," at the east of the Rocky Mountains, and lying principally between longitude 20° and 30° west from Washington, extending from Texas to the Arctic sea. These plains contain but little timber, or woods, and individual trees are rare. They mostly have a gentle slope from the west to the east, though in some instances gracefully undulating, clad with thick, nutritious grasses, and teeming with animal life. The soil, though compact, is a fine calcareous mould. The climate is comparatively rainless, storms being rare, except during the melting of the snows on the mountain crests, which swells the rivers, like the Nile, to irrigate rather than to drain the neighboring tracts. The herbage, which is perennial, edible and nutritious throughout the year, is peculiarly adapted to the dryness of the soil and the temperature of the air. It consists, principally, of the "Gramma" or "Buffalo" grass, and covers the ground an inch in height, having the appearance of a delicate moss. During the melting of the snows, in the immense mountain masses beyond the Great Plains, the rivers yield a copious evaporation in their long and sinuous courses; storm-clouds gather on the summits, roll down the mountain flanks, and discharge themselves in vernal showers. In this temporary prevalence of moist atmosphere, these delicate grasses grow, *seed in the root*, and are cured into hay upon the ground by the returning drought. It is in this longitudinal belt of eternal pasture that the llama and alpaca would thrive, if at all, in any part of our domains, where infinite herds of aboriginal cattle, the buffalo, the antelope, the elk, and wild horses abound, as well as the mountain-sheep, the white and black-tailed deer, and innumerable smaller game. They could be imported from Peru to a number of a few hundreds, by the way of the Gulf of California and the Gila, and presented as a token of friendship to the immense population of nomadic Indians, or their chiefs, by whom they should be protected under prohibitory laws.

Could these animals be suffered to remain unmolested for ten or twenty years, if successful, they would probably increase to thousands, and even millions, ever after while immense profits would result from their flesh, skins, and wool, besides using them as beasts of burden, in places inaccessible to the camel or the mule.

D. J. B.

THE QUADRUPEDS OF ILLINOIS INJURIOUS AND BENEFICIAL TO THE FARMER.

BY ROBERT KENNICOTT, OF WEST NORTHFIELD.

POCKET GOPHER, OR POUCHED RAT.

Geomys bursarius, RICHARDSON.

DESCRIPTION.—This species, when full grown, measures from nose to root of tail about 9 inches; tail a little over 2 inches. Different specimens vary much in size. The head is large, nose blunt, eyes very small, ears nearly concealed, whiskers few and much shorter than the head ; incisor teeth large, protruding beyond the lips, Opening exterior to the mouth are large cheek-pouches, which extend back to the shoulders ; these are lined with fur, and are quite unlike the comparatively small cheek pouches of the spermophiles, which open within the mouth. The legs are short, fore-feet strong, armed with very large curved nails, of which the middle one is the longest ; hind-feet and nails smaller ; tail nearly naked—quite so at the tip. The incisor teeth are yellow, the feet and nails white ; the general color of the body reddish brown, but lighter on the belly; the young are much darker than the adults.

As mentioned in the Agricultural Report of the Patent Office for 1856, page 79, the striped and grey prairie squirrels are also called "gophers," by persons not knowing the Geomys. But the most careless observer, who has seen both, cannot fail to distinguish this at once by its color, large feet, teeth, and nails, capacious cheek-pouches, short and nearly naked tail, general form of the body, and subterranean habits. The two genera are as widely different as any among our rodents.

The gopher is found on the prairies in most of the middle and northern parts of the valley of the Mississippi, west of that river, and towards the Rocky Mountains, and north to latitude 50°. It is very common in Missouri, Iowa, Minnesota, and parts of Kansas and Nebraska. I found it abounding throughout the valley of the Red River of the North, as far as Pembina, in latitude 49°. But north of this it was rare, and none had been seen below Red River settlement, in latitude 50°. East of the Mississippi, it has been found in some parts of Indiana, Michigan, and Wisconsin; and on the great prairies, in Central Illinois; also south and east of the Illinois River it is constantly met with. It is worthy of remark, if true, as alleged, that the part of Illinois lying between the Illinois and Mississippi rivers is entirely free from gophers, while they are abundant along the borders of the opposite sides of these rivers.

The gopher is properly a prairie animal, and, though I have observed it occasionally in the edges of woodlands, or in the small "prairie islands" on the Red River of the North, in Minnesota, yet I never found it in the heavy and extensive woods on the headwaters of the Red river and between Otter-tail Lake and the Mississippi. Though fond of dry, sandy soil, in which it can burrow easily, it does not abound on the sand-hills of the plains, as these are without sufficient vegetation to afford it food; neither does it generally bur-

row much about the wet edges of sloughs and streams, choosing rather the fertile and level, but dry spots, along hill-sides where, in some places, I could not walk without stepping upon its little heaps of earth, or breaking into its burrows, which frequently ran just below the sod; for, though the main galleries were much deeper, it also burrowed in every direction near the surface for the purpose of obtaining food. On the east side of Red River are remarkable sand ridges, sometimes miles in length and only from 5 to 10 rods in width. Generally, several of these lie parallel to each other, separated by regular intervals, about their own width, of low, fertile, and in some cases wet ground. These intervals are usually filled with a thick growth of small poplars, while the tops of the sand ridges, almost destitute of vegetation, are frequently quite level and straight for a mile or more; thus presenting an appearance strangely resembling a very smooth turn-pike road, between artificial belts of trees. In the narrow strips of sandy, but fertile and open ground, lying between these barren hills and the "poplar hammocks," I found these mounds and burrows in astonishing abundance, while the numerous dead tops of the liatris helianthus, and of various grasses and other plants, showed what the gophers had been digging after. Some of the poplars exhibited their ravages; but the roots of several species of helianthus appeared to be their favorite food.

It is one of the most facinating features in the study of zoölogy to notice how animals are constituted to live in every habitable part of the earth, and the nice adaptation of each to the situation it is intended to occupy. The fish cleaves the water by means of its fins; the light-boned bird is propelled through the air by the feathery appendages of its wings and tail, the former answering to the fore-legs of quadrupeds, so extended and modified as to form proper organs for such locomotion; the timid hare, from the superior length of her hind-legs, is enabled to spring fleetly over the ground; and the squirrel, from his great muscular power, to leap easily from bough to bough; while the gopher, organized for life in a different sphere, his form in every respect corresponding to his habits, passes his days as happily in his subterranean abode as the fish, the bird, the hare, or the squirrel, each in its appointed place. As the home of the gopher is underground, he does not generally come to the surface, except to remove the earth from his galleries. The peculiar form of his body, and powerful fore-feet and toes, would be of no use to him elsewhere; but here are necessary to his existence, enabling him to burrow through the earth with wonderful ease, while his capacious cheek-pouches furnish him with a means of conveyance larger than is possessed by any other animal of his size.

On the wild prairie, the gopher throws up a mound of earth of considerable size, frequently 10 feet in diameter and from 1½ to 2 feet in height, being highest in the low ground liable to inundation. In this mound is his nest, in which the young are bred; and from it, endless galleries are excavated in various directions, a foot or two below the surface. These are complicated, frequently intersecting and running together, and, in short, forming a complete network of

underground roads through which these strange animals can travel for miles. In digging them, the gophers run up shafts at irregular intervals from 2 to 10 feet apart, which open to the surface usually a little at one side of the main gallery, and from each of these side cuts they throw out the earth brought from the main gallery below, to the amount of from a quart to one or more bushels, and thus form little piles of earth by which the general course of the burrow may be traced. They have a remarkable antipathy to the light, and these side cuts are usually closed again with earth after they have served their first purpose; and, if a hole be opened into any part of the burrow, it is closed as soon as observed by the inmates. Only a portion of the earth taken by the gopher from his main highway is carried to the surface, much of it being used in filling the side cuts, into which it is packed, sometimes even more closely than the surrounding soil; and in digging about their burrows, I have thus been able to trace these cuts. The galleries are also apparently enlarged by pressing aside the earth. These are of greater dimensions than would seem necessary for the accommodation of an animal of this size. The main galleries are about 4 inches in diameter, and the side cuts from 2 to 3 inches. I am informed that, in digging wells, shafts have been found sunk by the gophers to a depth of 10 or 12 feet with water at the bottom. The opinion of those who have observed such holes usually is, that they are dug to procure water.

There has been some question as to whether gophers carry earth in their pouches; and even naturalists have said that they do not. These pouches, however, are certainly sometimes used, if not always, for carrying off the earth removed in excavating the burrows. These animals have been shot with their pouches filled with earth, and they have frequently been seen, both in captivity and while at liberty, in the act of emptying the earth from them. There seems to be a peculiarity in the manner in which the animal empties his pouches. It is done so rapidly as to puzzle the casual observer. Many persons inform me that, when watched, one of them may be seen at the moment it comes above ground, throwing the earth to some distance and instantly retreating into its hole. A gentleman writes me that one morning, about 9 o'clock, he saw a gopher, which had probably been alarmed at his footsteps, come out of the ground, and then, without noticing him, go back, and soon after reappear at the mouth of the hole with both pouches full of earth, when, by the mere muscular force of his pouches, he ejected some portions of it to the distance of 2 feet.

As observed in captivity, when the gopher begins to dig from the surface, he at first loosens the earth with his claws, aided sometimes by his teeth, then scratches it back with his fore-feet, and throws it further off with his hind-feet. As the hole deepens, he does not always carry out the earth in his pouches, but frequently, after throwing it behind him a short distance, turns round and simply pushes it forth with his head and shoulders, sometimes filling his pouches first, and pushing before him a quantity of earth besides. In carrying it from some distance within his burrow, however, he appears oftener to

convey it all in his pouches. The old "gopher hills" are usually covered with luxuriant vegetation, and, when numerous, give to the wild, level prairie a singular and agreeable aspect. They are frequently chosen as burrowing places by badgers, foxes, and wolves.

Though a lover of darkness, this animal is sometimes active by day. In its subterranean abode, it cares little whether it be night or day above; but it does not often carry earth to the surface on bright sunny days, though it may be seen at work in cloudy weather, and early in the morning or late in the afternoon, and, though still more rarely, may be found moving above ground at such times. These animals ocasionally have been known to travel from one district to take up their residence in another. These migrations are performed at night, and it is chiefly at this time also that they leave their burrows to seek food on the surface.

The proper food of the gopher consists of roots, which are usually obtained without leaving his underground roads. Though he sometimes comes to the surface to feed upon the leaves and seeds of plants, this does not appear to be his principal means of subsistence. The manner in which he naturally procures food is by approaching it from below, without coming above ground at all. He lays up stores, apparently, at all seasons. Considerable quantities of the roots of the rosin-weed, *(Silphium laciniatum,)* wild artichoke, or wild sunflower, *(Helianthus?)* spike flower, *(Liatris?)* and various other plants, are collected in its burrows on the prairies; while, in cultivated fields, I am informed, the roots of the grasses, potatoes, and other vegetables are found in its holes.

Whether the gopher secludes itself in its burrow during winter is not certain, but probably it does not; or if so at all, the hibernation is not perfect, as it is seen out late in autumn, and observed to be active early in spring, making its first appearance at irregular periods. Some persons have stated that they have seen fresh earth thrown out by it in the winter. This, if correct, would prove that the animal does not fully hibernate. The mere fact of its collecting a store of food for use in winter, however, is by no means conclusive.

Occasionally, the sudden rising of prairie streams, by heavy rains, inundates low spots inhabited by the gophers, drowning them in their burrows. Those who have observed them at such times say that they appear to be unable to swim.

Gophers are very pugnacious, fighting savagely with each other, and offering battle when met by man. They probably suffer but little from rapacious animals; for they appear capable of formidable resistance to the attacks of small carnivorous mammals, while they are protected by their habits from the larger ones, and from birds of prey. The common domestic cat has been known to capture them, but often the attempt failed.

It has been said that gophers are social in their habits; but I am unable to learn that more than two adults are ever captured at the same place; and, in a communication published in the Report of the Smithsonian Institution, it is stated that, if two are placed together, they at once attack each other, and the victor devours the vanquished.

The writer's observations would also go to prove that this, like most rodents, will sometimes eat flesh.

Five or six young are usually produced at a birth, and there is apparently but one litter in a year. It is stated that, in Missouri, the young are brought forth late in March or early in April. A gentleman informs me that, in Iowa, he has observed they are produced in May; and further states that he found young in every nest examined by him. If gophers hibernate, as has been supposed by some writers, the young could not be produced so early as the first of April in this latitude.

Wherever they exist on cultivated land, the gophers are very injurious. No animal is more complained of by our prairie farmers. Scarcely a crop escapes their ravages. They are said to desert the wild prairie to inhabit cultivated hay-fields; and they particularly delight in clover and Timothy meadows. Here they not only do mischief by devouring the roots of the plants, but impede the mowing and raking of the hay, by inequalities of surface caused by their mounds. Grain fields are much injured by them while the plants are growing; and, when the stacks are left standing after harvest, the gophers burrow from below, and frequently cut up and drag into their holes, or otherwise completely destroy, entire sheaves. All root-crops suffer severely from them. In passing below the surface, they gnaw off the bottoms of carrots, beets, turnips, and other tap-rooted vegetables, without disturbing the tops or coming above ground. In fields of common and sweet potatoes, they work under the hills and remove the tubers, and thus sometimes destroy half or more of the crop before the dying vines give evidence of the mischief. Instances are related in which potato heaps, covered with earth and left out during winter, have been entered by the gophers and the tubers carried off. They sometimes enter melons, pumpkins, and squashes, through holes at the bottom, and eat out all the fleshy part, and then fill the hollow rind with earth, leaving it in a condition to create much astonishment when harvested. They also feed upon the bark of the roots of trees, as well as upon the fleshy roots of herbaceous plants. Some of our prairie farmers are greatly injured by their destruction of Osage-orange hedges. No small item of their injury is the gnawing and cutting off the roots of fruit-trees. A considerable portion of all the trees have been killed annually in some young orchards in Iowa and Illinois; and several fruit-growers inform me that they have seen as many as a dozen large bearing apple-trees killed by them in a single orchard. Forest trees, 6 or 8 inches in diameter, have died in consequence of their roots being cut.

From his habit of keeping constantly under ground, the gopher suffers but little either from man or wild animals. He can only be shot after being watched patiently near the opening of one of his side-cuts, out of which he has recently thrown earth; and here the gun must be kept aimed at the hole, and discharged the instant his form comes in sight, or he will throw out his load and retreat before the gun can be levelled and fired. Trapping is the most successful mode adopted for capturing this animal. A hole being opened into a

gallery known to be travelled by him, a small steel trap, covered slightly with loose earth, is placed in the track, in such a position that, when he comes to shut out the unwelcome light, he must unavoidably be caught. It is not necessary to bait a trap thus used. The Missouri gophers can doubtless very readily be poisoned by strychnine or arsenic in pieces of vegetables placed in their burrows, as is sometimes practised with the California species. There could be no danger attending this, and the probability is that the method would be highly successful. A number of gentlemen inform me that they have, by perseveringly trapping and shooting the gophers, completely cleared them from their farms at times; but all complain that they soon return from their neighbors' fields. Why do not all the farmers in a district meet and agree to use all reasonable exertions within their power to kill the gophers and other injurious animals for a certain period? It is very certain that nothing but concerted action is likely to avail much in this matter. I would suggest that agricultural societies should offer premiums for the farm on which most success has been attained in destroying the injurious mammals and insects, and in protecting such of their natural enemies among the rapacious birds, reptiles, insects, and other animals, as are not themselves actually too prejudicial to be tolerated.

In Georgia and Florida, another species of this genus *(Geomys pinetis)* is found, where it is known under the name of "Salamander," whereas a terrapin, or fresh-water turtle, is called "gopher." The pouched rat of Arkansas is also called "Salamander." The name "gopher" is derived from the appellation of *gauffre*, given these animals by the Canadian voyageurs. It is stated that, on the Upper Missouri, they are sometimes called "mulos." Twelve species of gophers inhabiting the United States are described in Baird's General Report on Mammals in the Pacific Railroad Survey. Of these, only the present species and that of Florida are found east of the Mississippi. The Californian species *(Geomys bulbivorus)* is even more destructive than that of Illinois.

COMMON GREY RABBIT, OR HARE.

Lepus sylvaticus, Bachman.

Description.—*Adult male.*—Length of head and body, $16\frac{1}{2}$ inches; vertebræ of tail, $2\frac{1}{4}$ inches; length of hind-feet, 4 inches; height of ears, $2\frac{3}{4}$ inches; feet clothed with long hairs, which conceal the toes; color above, yellowish-grey, mixed with brown; below, whitish. Does not become white in winter, like the large varying hare (*Lepus americanus.*) All the hares have large prominent eyes, very long ears, and short, almost rudimentary upturned tails; and have the inside of the mouth and soles of the feet furnished with hair. Behind the large incisors, common to other rodents, they have on the upper jaw a second pair of small incisive teeth. The hind-legs are very long and muscular, and by means of these they travel by leaps made with but little assistance from the weaker fore-legs.

Though called "Grey Rabbit," in Illinois, as, indeed, it generally is throughout its habitat, this, like other American species, is a true hare, and, like the European hare, has a "form," and the young are

born clothed with hair, with the eyes open; while the European rabbit burrows, and is born naked and blind; but, as their organization is otherwise the same, both rabbits and hares are included in one genus. The European burrowing rabbit (*Lepus cunicularis*) is frequently kept in this country in a domesticated state.

The grey rabbit exists nearly throughout the eastern half of the Union, and south of the Gulf of Mexico, but it is not found far northward. It is abundant at least as far west as Iowa and Minnesota. This well-known species is fond of dry, level ground, rather thinly wooded, and interspersed with thickets and open spots. In Northern Illinois, where the prairies are traversed by streams, bordered by trees, or dotted with groves, the grey rabbit is very abundant, particularly in the groves and edges of the larger woodlands where clumps of hazels and briers are numerous. This hare is properly an inhabitant of the woods, and though sometimes abounding for several miles on the prairies, it is not so much at home there as in the neighborhood of trees, among which it finds better shelter from its innumerable enemies. Many, which spend the summer on the prairies, are believed to return to the woods in winter. As the wild prairies become settled, the rabbits are observed to live further from the forests, seeking shelter about fences and stacks. In the hilly and heavily-timbered regions of Southern Illinois, this species is less abundant.

The "form" of the grey rabbit is in some concealed position, by the side of a log, in a small brush heap, or at the root of a bunch of briers and weeds, if in the woods; or it is frequently situated in the grass at the edge of the prairie, or of the sloughs that run into groves and outskirts of the woods; and here, as well as on the prairie, it is where the overhanging grass shelters and conceals it. The form, in fact, is only a particular spot to which the rabbit retires to spend the day, and is merely a slight depression, sometimes with a few grasses and leaves drawn together, little or no art being ever used in its construction; though, as before mentioned, it is usually in a position somewhat concealed. The same individual sometimes has several forms, and, in winter, one is frequently chosen in a more sheltered position than that used in summer. But in winter, it does not always occupy a form, often being found in hollow trees, whether fallen or upright, as well as in holes in the ground. It usually retires, however, to these situations only in severely cold and stormy weather, or for refuge when pursued.

Though holes in the ground are often occupied, they are not dug by the rabbit, but are the deserted burrows of some other animals. It is true that the female scratches shallow holes in which to bring forth her young, in open fields, but it is rarely indeed that rabbits of this species dig burrows. I am credibly informed of a few instances in which they have been known to dig holes for themselves in hillsides; but these may be considered as departures from their natural habits. This rabbit is not pugnacious, several even taking refuge in the same hole; but though they exist in astonishing abundance in particular localities, they are not naturally gregarious.

The grey rabbit is exceedingly timid, and rarely or never makes the slightest resistance when attacked by other than its own kind. Its only attempts to escape its enemies are by speed and stratagem. When pursued, an old male exhibits as much cunning as a fox—doubling, turning aside, and permitting the dog to pass, and then running on the back track; going through water, which it dislikes; and frequently springing upon a log and sitting motionless, while the dog, in plain sight, beats around within a few feet of the spot. Usually, when one of these animals is started by dogs, it runs a short distance, and, unless closely pursued, turns aside and stops. The dog generally passes it, when it at once returns to the neighborhood of its form; or, if unable to do so, directly, an old one will frequently manage, by repeated doubling, to elude its pursuer, and reach its form again by a circuitous route. Should it be closely followed by a fleet dog, it will make for a burrow, or a hollow tree, which has an opening at the ground into a cavity extending some distance above, up which it forces itself by bracing against the sides. Young rabbits are not so apt to double and attempt to turn back to their forms, but often run immediately to a tree; and an old one will sometimes take to a hole without much doubling, especially if it has before been chased and found refuge in the same retreat.

When seized, the grey rabbit never makes any attempt to bite. It utters a clear, sharp, wailing cry, like *que-a-a-a*, which is its only note, and is never heard except in distress. At other times, this animal appears to be voiceless, except that, in fighting, or playing together, the males produce a low, purring sound, scarcely above the breath. They also make a noise by stamping upon the ground with the hind-feet.

Like its congeners, this species has a very acute sense of hearing, and, when running, it stops and listens to any extraordinary sound. Though it has not good "bottom," its speed for a certain distance is great, enabling it to outrun almost any dog. It always travels by leaps, its powerful hind-legs and the immense muscles of the back enabling it to take long bounds, sometimes of 10 or 15 feet, in which it is but little aided by the weak fore-legs. It never appears to run or "trot," and, when it walks at all, as in eating, it rests the hind-feet upon the ground, only moving a short distance on a walk, and more generally hopping along by jumps of about a foot. This, like all other hares, is nocturnal, or, perhaps, more properly, crepuscular, moving about for food and amusement chiefly by twilight, or on moonlight nights. It is frequently seen standing, however, on open ground in the sunshine, especially in spring and summer.

The position of the rabbit's feet, in running, is not always understood. I well remember my astonishment when, upon examining their tracks the first time, I found, as I thought, that they always ran backwards. For, the slight tracks of the fore-feet are really situated behind the larger and more widely separated prints of the long hind ones. As this animal springs, the fore-feet strike the surface near one another, while the hind-feet are spread apart and brought to the ground some distance in advance, outside of them; as these strike,

the fore-feet, which have touched the surface but lightly, are lifted, and the spring is again made with the hind-legs alone. In making the longest leaps, the fore-feet strike in a line, one behind the other, and at some distance in the rear of the hind ones, as if they had been again raised before the latter had touched the surface.

Rabbits are very active, moving about at all times, except in very cold and stormy weather, when they keep close in their retreats, sometimes not leaving them for a day or two, and not unfrequently lying in their forms in the tall grass completely buried under the snow. Wherever two or three of these animals occupy a neighborhood, long well-worn paths may be found beaten in a single night, after a light snow in mild weather. Particular paths are used even when there is no snow, the same track being travelled repeatedly by one or more individuals.

The food of the grey rabbit is grass and other herbage, the tender shoots of briars, and various shrubs, as well as the buds, twigs, and sometimes, perhaps, the bark of trees. I have never observed that it gnaws hard-shelled nuts, like those of the hickory, though it is said to eat chestnuts; nor does it generally, if ever, dig through the snow for food. It does not hold food in the paws when eating, like many rodents, nor does it usually sit erect upon the tarsi. The domesticated rabbit, in eating a twig, holds it in its lips, and continues, without laying it down or ceasing to masticate rapidly, to cut off pieces from the end with the incisors, until the whole is devoured. This species doubtless eats in the same manner.

Rabbits are sometimes quite injurious in gardens, by devouring young plants of beans, cabbages, lettuces, and all kinds of vegetables; and where very abundant, they occasionally damage harvest fields, though they do not appear to feed very generally upon ripened grain. But their most serious injury is the destruction of fruit-trees, by cutting off the shoots and, perhaps, sometimes gnawing the bark. Their damage to fruit-growers in this way is at times very great, and leads to bitter complaints. When the ground is covered with snow, they enter gardens and nurseries and bite off and devour small shrubs and fruit-trees; or, if the snow be of sufficient height to enable them to reach the branches of orchard-trees, these, too, are eaten and their tops sadly disfigured. The branches are taken off with the rabbit's incisors so smoothly as to leave the appearance of their having been cut with a knife, and more than one orchardist has wrathfully sought the persons who "stole scions." Rabbits are said to kill fruit-trees by gnawing the bark from the trunks, and in this manner to have utterly ruined large and valuable orchards. Fortunately, however, this reported bark-gnawing appears to be generally, if not always, done only when the rabbits cannot reach the buds and branches upon which they prefer to feed, eating the entire branch. In hunting these quadrupeds, every winter, and working every summer, for ten years, in a very large nursery of fruit-trees, where they were numerous, I have never seen a tree from which bark had been gnawed by them, though thousands were severely "pruned," the rabbits, in deep snows, appearing to feed entirely upon the twigs and

buds of the young apple trees. From the larger limbs they cut off the buds, of which they are fond; and in the woods, in winter, they can be tracked to living forest trees, recently felled, to which they repair to feed upon the buds. They also feed in winter upon the buds and young shoots of briars, sumach, hazel, thorn, oak, hickory, basswood, poplar, and other shrubs and trees.

It is highly probable that, injurious as rabbits are considered, by gnawing bark, the mischief charged to them is often, if not generally, done by meadow mice alone. It must be remembered that in deep snows the arvicolæ can readily climb some distance up the trunks of the trees, and I have frequently observed them to gnaw bark at a height of two feet or more from the ground. If these animals do gnaw the bark of fruit trees, as reported, it must be when they cannot reach the limbs or obtain any other food. A gentleman living on a prairie farm in Northern Illinois, informs me that, though many rabbits frequent his orchard throughout the year, he has never had a single tree barked by them; and in such a situation they might certainly be expected to gnaw bark, if ever Though I am inclined to believe that they do not injure the farmer by bark-gnawing to the extent usually supposed, yet I by no means wish to defend them from the just charge of committing great havoc in nurseries and gardens by biting off young plants; but would rather suggest that the true criminals—the meadow mice—be destroyed, as the best means of checking the evil.

The grey rabbit is very prolific, producing young three or four times a year, and usually from four to six at a birth. In open ground the female scratches a shallow hollow, in which to bring forth her young. In this she forms a nest of soft leaves and grasses, well lined with fur from her own body; and when she is absent, the young are always completely covered and concealed in this nest, which they leave at an early age, and separate from the mother as soon as able to take care of themselves.

It is pleasant to observe that an animal usually so timid and unresisting will fight bravely for its young. A naturalist tells me that he once saw a grey rabbit attack a large black snake, which was holding one of her young in its coils. She fought by springing over the snake, and striking back with her hind-feet, which is the usual mode of defence of this species. Her blows were delivered with force and precision, and so rapidly that the snake was struck nearly every time, despite his attempts to evade them. As she passed, the snake aimed at her with his fangs, but though he often scratched off a mouthful of hair, he was plainly getting the worst of the battle, when the naturalist interfered. Another instance is related in which a rabbit was observed to pursue a hawk in the act of carrying off her young.

The grey rabbit is not only preyed upon by various carnivorous mammals, but by many rapacious birds found here, as well as by the larger snakes. The musteline mammals, or animals of the weasel family, are the most to be dreaded. They search out the retreats of these animals, and, as most of them can enter wherever the latter pass, they readily follow, and kill them unresisted. I suspect the

6 A

little brown weasel (*Putorius cigognanii*) subsists largely upon them in winter in this region, as does the larger white weasel (*Putorius noveboracensis*) which is also said to be their worst enemy at the East. I have repeatedly observed the track of the common mink for a great distance, as it wound about logs and brush-heaps, often entering hollow trees and burrows, sometimes following a rabbit's track, till finally I have come to where an unhappy victim has been pulled down from a tree in which it had in vain sought refuge. In Northern Illinois, numerous cats, which have escaped from domestication, and live in the woods like wild animals, frequently prey upon them. Among the birds, the great horned owl is noted as a successful rabbit-catcher. The white owl occasionally seizes one, in winter, as it sits on its form on the prairie; and the red-tailed buzzard, or "hen-hawk," as it is called, frequently swoops upon one of them in summer. Their young are destroyed in great numbers, as they fall an easy prey to any animal which finds them, when too small to escape by flight; and a large proportion of the whole number produced are probably thus doomed before the period of maturity. Many rabbits are infested by the larvæ of a large gadfly, (œstrus,) and are hence said by hunters to have the "wolf." In their fur live astonishing numbers of a peculiar flea, apparently differing from the common species.

In cultivated districts, where many of the natural enemies appointed to check their increase are destroyed, the rabbits frequently multiply to such an extent as to render their extermination a matter of importance. Then they are easily trapped or snared, and may readily be poisoned by arsenic or strychnine, placed in a bait of apple, turnip, or other vegetable; but the most effectual mode is to encourage the hunting of them.

As before stated, the grey rabbit often has his form situated in the tall grass, at the edge of the prairie, or in sloughs running into the woods. By walking along between these and the trees, where there is generally a space clear of cover, while a dog beats the grass beyond, one may get a shot at them, as they will almost always make straight for the woods. The rabbit will generally "lay" to the dog, giving him a fair chance for a "point," so that one may come up and take a shot as he goes off in a direct line, if that is preferred to a cross shot. If he cannot be brought down at first, the dog, by following on the track, will start him the second time, when he may be shot as he comes back, unless the dog should compel him to retreat into a tree. The finest shot should be used in shooting rabbits, for they are very easily killed, and generally drop at a slight wound. I have, more than once, shot one, however, without injuring a bone, when he would run half a mile, and then fall dead without a struggle. A more primitive mode of hunting them, I believe, is practised by boys, which is to go armed with a small sharpened pole and some matches, accompanied by a dog to chase them into hollow trees. Sometimes the hole in the tree is such that one can reach the animal with his hand, or pull him down with a short hooked stick; but when he is out of reach, and the boy without an axe for cutting into the hollow of the tree, a stick is introduced to "poke him out;" and

shortly after, in an agony of fright and pain, he rushes down the hollow, and the boy quickly grasps the legs of the captive. When the game cannot be brought down with the stick, leaves are collected and fired at the entrance of the hollow, and in a short time, the suffocating animal unavoidably descends.

When chased on the prairie, if there are no stacks of hay nor grain under which to find refuge, the rabbits take to the long, heavy sedge grass (carex) in the sloughs, where, by doubling and shifting about, they generally elude the pursuit of the dogs. They are also snared in great numbers upon their path-ways. The following is a very simple but successful method of capturing them: A small thickly branched tree is felled across the path-way, with the limbs so arranged as to leave but a single narrow passage; an elastic sapling is then bent down over this, and tied by a cord to the fallen tree, or to a hooked peg, driven into the ground. at the side of the opening; this is not tied to the peg by a common square "hard knot," but only with what is called a "single bow-knot," so that the pulling of the end of the cord frees the whole. In order to prevent the strain given by the bent tree from pulling it out, an enlargement is first formed by knotting the cord just within the point at which it passes from the bent tree, under the part of the cord passing around the peg, so that, although this protuberance does not permit the cord to be drawn through from above, neither does it interfere with the loosening of the knot by drawing out the bow, if the other or lower end be pulled. This lower loose end of the cord is formed into a noose a little larger than a rabbit's head, and placed open in the path, so that the animal, in attempting to pass, readily puts his head through; but in his endeavor to force through his shoulders not only tightens the noose around his neck, but pulls out the bow; thus loosening the knot, when the bent sapling, being freed from its attachment, springs up and breaks the rabbit's neck, or suspends him until he is strangled. A very smooth, tightly-twisted cord should be used; the noose is sometimes formed of brass wire, which keeps its position and slips easily, and is not liable to be cut by the animal before entering, like the cord. A little practice is necessary in learning to arrange the knot, so that, when loosened, the noose will not be drawn up on the wrong side and entangled; and the arrangement of the whole will be better understood after a few experiments. In consequence of the rabbit's well known habit of travelling in accustomed paths, which may be discovered even in summer, it is not necessary to use any bait, though pieces of apple, parsnip, or cabbage placed in the path on each side of the snare might more fully insure success; and the snare may also be set at the entrance of a little pen, or hollow tree, in which is placed a bait. I learn from a gentleman of Pembina that, on the Red River of the North, the Indians subsist, in hard winters, when game is scarce, almost wholly upon hares caught in this way. Grouse, quails, and many other animals can also be successfully snared; and it is said that even the moose and the deer have been caught in snares constructed on a larger scale. Hares may also be caught in

steel traps and "dead-falls;" and, in fact, they will enter almost any kind of trap.

The grey rabbit frequently takes up its abode about farm-yards, and I have often observed individuals living all winter under stacks and buildings situated within a few rods of dwellings, making nightly sallies into the garden, greatly to the injury of the plants, many of which they destroyed. In one instance, within my observation, a mink did good service, and amply paid for the two or three fowls he consumed, by ridding a farm-yard of several rabbits which had thus taken up their quarters under the barn and hay stacks, and were making sad havoc among some choice plants in the flower garden. As long as the mink remained, no rabbits were observed on the premises, though before and after his visit their tracks were seen in every direction, despite the presence of two dogs accustomed to hunting. Where rabbits are troublesome, and no fowls are kept, the presence of minks and weasels is desirable, especially of the weasels, the good offices of which in the destruction of rats and mice, both in the field and farm-yard, often save a single farmer more than the value of all the fowls destroyed for years in a large neighborhood; yet there are few who ever willingly spare the life of a weasel. Indeed, it is frequently killed while in the very act of hunting the far greater enemies of agriculture. A gardener once expressed to me his satisfaction at having slain several garter-snakes and a green snake, which had caused great alarm and discomfort about his home. They infested his rose-bushes; but the good gardener knew not that they resorted thither to destroy the green slugs of which he had so long complained, and that the snakes themselves were harmless to man. So, too, whoever kills weasels on his farm, at a distance from the poultry, might find it profitable to consider what they feed upon.

Grey rabbits sometimes form a considerable item of human food, and are sold in our city markets, in winter, in large numbers at a price of 10 or 12½ cents each. The flesh is rather dry, and without much flavor, and is generally not deemed eatable in summer.

THE NORTHERN HARE, VARYING HARE, OR WHITE RABBIT.

Lepus americanus, Erxleben.

Description.—This species is considerably larger than the grey rabbit, and has the hind-feet much longer. It is from 16 to 19 inches in length; the hind-feet from 4½ to 5½ inches long, and the ears about 3½ inches in length. The color in summer is reddish-brown above, and white beneath, with the tail sooty-brown above. In winter, the upper parts become nearly white in high latitudes, but in Northern Illinois retain a brownish tinge. On the outside of the ear is a narrow black border.

The Northern hare is sometimes called "rabbit," in common with the Lepus sylvaticus. It is a northern species, and inhabits the eastern part of North America, from about latitude 68° southward to 40° in the United States, though it is rarely found that far south. It has

been stated that a number were shot on the present site of the city of Chicago, in the winter of 1824. I have been unable to ascertain whether they have been found further south in this State. This species is not uncommon in Central and Northern Wisconsin, and considerable numbers are found in the southern part of that State.

The northern hare is strictly an inhabitant of the woods. Unlike the grey rabbit, it prefers the deepest forest. In winter, it sometimes abounds in the swamps, where it forms many paths, showing even more inclination than the grey rabbit to travel the beaten track. In summer, however, it avoids wet places, and chooses higher ground, at all times being fond of a thick undergrowth of young evergreens.

These hares have no other retreat than their forms. When pursued, they are never known to enter hollow trees nor burrows, but try to elude the dogs by doubling and winding through tangled thickets. They are swift on foot, and frequently outrun the fleetest dog, finally escaping. They are shot on their paths, or started from their forms and shot as they run. Like the grey rabbit, they often return to the neighborhood of their form after being started, and are thus shot by the hunter who watches at the spot while his dog pursues them. I am informed of the same habit in the California hare. Though larger than the grey rabbit, and more valuable in the market, its flesh is less esteemed, as it is even more insipid and dry.

Being less prolific than the grey rabbit, the northern hare never exists in great abundance. I am not aware that it is, to any considerable degree, injurious to the farmer. Its food in the woods is similar to that of the grey rabbit, but it neither enters gardens nor comes about stacks and barns, like that species.

SWAMP RABBIT, OR WATER HARE.

Lepus aquaticus, BACHMAN.

DESCRIPTION.—This species is very large, exceeding the grey rabbit and the Lepus americanus in size. The dimensions in inches, as given by Professor Baird, of a specimen from Louisiana, are, from nose to occiput, $3\frac{85}{100}$; nose to tail, $20\frac{1}{2}$; tail to the end of vertebræ, $1\frac{75}{100}$; tail to the end of hairs, $2\frac{68}{100}$; length of hind-feet, $3\frac{88}{100}$; height of ear, anteriorly, $2\frac{88}{100}$. The dimensions of a smaller specimen from the same locality are, from nose to occiput, $4\frac{1}{10}$ inches; nose to tail, $17\frac{1}{2}$; tail to end of vertebræ, $1\frac{3}{5}$; tail to end of hairs, $2\frac{2}{5}$; length of hind-feet, $4\frac{7}{100}$; height of ear, anteriorly, 3 inches. The head and incisors are large; ears scarcely half the length of the head; hind-feet shorter than the head, and pointed; claws uncovered; tail as long as the ears; color above, yellowish-brown, closely lined with black; sides greyer; forehead containing a black spot; tail above, rump and legs, chestnut-brown; tail beneath, and belly, cottony white; under fur, on the anterior portion of the back, without any yellowish-brown tips.

The head and incisor teeth of this species are remarkably large, while the ears and hind-feet are as strikingly small, when compared with other hares; and the feet, instead of the heavy covering of fur, such as is found on those of the grey rabbit and varying hare, are scantily clothed, leaving the toes uncovered. It bears a general resemblance to the grey rabbit, but may at once be distinguished by its greater size, large head, and incisor teeth, as well as the scanty

fur on its feet. It need not be mistaken for Lepus americanus, as the two never inhabit the same region; and a striking difference is the black on its back, the white under-surface of its tail, the shorter hind-feet with uncovered toes, and the fact of it not becoming white in winter.

The Lepus aquaticus is abundant in Mississippi and Louisiana and probably along the Mississippi, at least as far up as the southern part of Illinois. It is not uncommon in the swampy "bottoms" near Cairo, and in neighboring localities in Kentucky and Missouri, where it is recognized by the hunters as distinct from the common grey rabbit, by its larger size and peculiar fondness for low and swampy grounds. At New Madrid, Missouri, I learn that it exists in the swamps of that neighborhood.

In its singular semi-aquatic habits, this species differs remarkably from all other hares, except the marsh hare (*Lepus palustris*) of Florida, Georgia, and the neighboring States. It lives constantly near water, in low and swampy grounds, feeding chiefly upon paludal plants; and it not only takes to the water and swims readily, but even dives without hesitation when pursued. In Southern Illinois and Missouri it is observed to prefer the densest forest as well as the vicinity of water, being rarely seen on the hills or in open woods. It abounds in the deep cypress swamps and dark heavily-timbered "bottoms" along the Mississippi. On dry ground, as in the swamps, it generally rests upon logs, stones, or other elevations, in preference to sitting in a form on the ground ; a habit probably acquired from the necessity of choosing an elevated seat when inhabiting the swamps.

At New Madrid, I was informed, this rabbit is readily captured by being chased into trees by dogs; for, though fleet, it soon takes to a hollow tree, like the common grey species. It is said that when pursued, it runs towards the nearest water, as if to seek an element which would leave no trace of its scent. Often, too, after swimming a creek or pond, it will hide under the bank or among the roots of trees.

The young of this species are stated to be produced at least twice a year, to the number of from four to six at a litter, in nests on hillocks in the swamps, or in fallen hollow trees. From its habit of living in marshy ground and deep woods, this animal will probably never be found injurious to the farmer in any considerable degree. In Southern Illinois and Missouri, its flesh is preferred to that of the grey rabbit. I believe no hare has been known habitually to eat insects or animal food of any kind. Indeed, the hares may be regarded as the most strictly herbivorous of our rodents; for, though all the gnawing animals are properly vegetable eaters, most of them depart from their legitimate food to some extent by occasionally eating insects, while several, as the spermophiles, even devour birds and mammals.

The three hares here described, with the Lepus palustris, of Florida and Georgia, are the only species now known to exist in the United States east of the Mississippi; though, west of that river, there are at least seven other hares. Some of these Western species are remarkable for their habit of living exclusively on the prairies.

RED MOUSE.

Hesperomys Nuttalli, BAIRD.
Arvicola Nuttalli, HARLAN.
Mus aureolus, AUDUBON and BACHMAN.

DESCRIPTION.—The dimensions in inches of a large female from Southern Illinois, are, from nose to tail, $3\frac{1}{2}$; tail to end of vertebræ, $2\frac{1}{8}$; tail to end of hairs, $2\frac{41}{64}$; length of hind-foot, $\frac{3}{4}$. This species is about the size and proportions of the common deer-mouse, (*Hesperomys leucopus*,*) which it closely resembles in form, though the head and feet are shorter, and the tail nearly naked. The entire upper parts are bright brown, or yellowish cinnamon, darker on the back, and brightest on the shoulders and cheeks; the ears are cinnamon; the tail brownish above, and white on its under surface; the belly is cream-white, the feet silvery-white. In life, the nails and tips of the toes are bright reddish flesh-color.

This very beautiful little animal will at once be distinguished from the common deer-mouse by the bright cinnamon color of the entire upper parts, especially of the ears, and by the creamy or yellowish tinge of the belly, as well as by the shorter hairs of the tail, which appears nearly naked. In the deer mouse, (*Hesperomys leucopus*,) the color of the upper parts is light yellowish-brown, with a blackish line along the middle of the back, and the belly white. The young of Hesperomys leucopus are slate-colored above, while those half-grown of Hesperomys Nuttalli are nearly as bright cinnamon as the adults. In some parts of Southern Illinois, I found this species to be well known, as distinct from the common deer-mouse, under the name of "Red mouse." It exists from Pennsylvania south to Georgia, and west to Missouri and Mississippi. I captured two at Murphysboro', and it is not very uncommon near Salem, in Marion county. It is seldom found, if ever, in the northern part of this State.

The red mouse appears to be strictly an inhabitant of the forest, like the deer-mouse, (*Hesperomys leucopus*,) to which it is closely allied in habits as in form. Farmers who had repeatedly observed this, as well as the deer-mouse, in the woods near Salem, inform me that they never heard of the red mouse on the prairie, though it frequented clumps of hazel bushes at the edges of the prairies. It is also stated that the common deer-mouse was found upon the prairie in that vicinity; but, on procuring specimens of this prairie species, it proved to be not the common deer-mouse of the woods, (*Hesperomys leucopus*,) but the prairie white-footed mouse, (Hesperomys Bairdii,) described in the last Patent Office Report. Thus the existence of the Hesperomys Bairdii throughout the prairie regions of Illinois is established; but it has not been discovered in the heavily-timbered country in the extreme southern parts of the State.

The red mouse is more arboreal in its habits than the deer-mouse. I observed one, when driven from its nest, at once take refuge in a tree, instead of running off on the ground, and I am informed that these mice have frequently been seen climbing trees and shrubs. From a gentleman, of Salem, I learn that this, like the deer-mouse,

* In the description of the common white-footed mouse, or deer-mouse, and of the prairie white-footed mouse, published in the last Patent Office Report, the names of these species were printed "Mus leucopus" and "Mus Bairdii," instead of Hesperomys leucopus and Hesperomys Bairdii. No species of the restricted genus Mus, which includes the introduced house mice and rats, is found native in North America—our white footed mice of the style of the common dun-mouse, all belonging to the genus Hesperomys.

builds nests in the branches of small trees, and that several were found in the tops of hazel bushes, and built neatly, somewhat like a bird's nest, but covered at top, with a small opening on the side. Judging from the number of nests observed, this species must build them more generally than the deer-mouse. The only two specimens of this mouse which I have seen alive, were an old female and a half-grown young one, found together in the month of May, in a slight nest formed of soft fibres of bark, and placed on the ground under a log. There was no burrow, either beneath nor near the log, though the female had evidently reared her young in this nest. The species probably does not generally burrow at all. When seized, it did not attempt to bite. Like the deer-mouse, probably it is not pugnacious, and, like that species, again, it is doubtless strictly nocturnal.

The food of the red mouse appears to be seeds and nuts, like that of the other species of hesperomys. It can hardly become a serious evil to the farmer, as it seems to be nowhere abundant, and is apparently less prolific than the Hesperomys leucopus; the female, which I caught, had but four mammæ. It is said not to be common in the Eastern States, and, though found occasionally throughout Southern Illinois, I was unable, during several months spent in collecting in that locality, to find more than two specimens. It appears, however, to exist in unusual numbers in Marion county. From its elegant form, beautiful colors, and activity, it would make a very interesting pet.

RED-BACKED MEADOW-MOUSE.

Arvicola Gapperi, VIGORS.

DESCRIPTION.—The dimensions in inches of several specimens from the Red River of the North, measured in the flesh, are: Adult male, from nose to eye, $\frac{1}{2}$; nose to ear, 1; nose to occiput, $1\frac{3}{16}$; nose to tail, 4; tail to end of vertebræ, $1\frac{1}{2}$; tail to end of hair, $1\frac{3}{4}$; length of hind-feet, $\frac{3}{4}$; height of ear. $\frac{7}{16}$. Adult female, nose to occiput, $1\frac{1}{8}$ inches; nose to tail, $3\frac{3}{4}$; tail to end of vertebræ, $1\frac{1}{2}$; tail to end of hair, $1\frac{3}{4}$. Young of the year, nose to occiput, $1\frac{1}{16}$ inches; nose to root of tail, $3\frac{1}{2}$; tail to end of vertebræ, $1\frac{1}{4}$; tail to end of hairs, $1\frac{1}{2}$. The form is decidedly more slender and light than that of any other of our arvicolæ, and approaches somewhat to that of the white-footed mice (hesperomys.) It is rather small, with slender feet, and the tail long, as compared with the other species. The ears are remarkably large, being $\frac{1}{2}$ inch in height, and higher than wide, projecting nearly $\frac{1}{4}$ of an inch beyond the fur; while in our other meadow-mice the ears are nearly, and frequently quite, hidden by the hair. The eyes are large, the nose very pointed, and the whiskers long. In the adult male the upper parts of the head, and along the middle of the back to the tail, are of a clear bright brownish-chestnut. The upper surface of the tail, the hairs clothing the edges of the ears, and a spot in front of the ears, are of a duller chestnut. The cheeks and sides are brownish-grey; the forehead and nose dark-grizzly or grizzly-brown; sides of the muzzle and entire under parts clear greyish-white; under surface of the tail greyish, with a chestnut tinge towards the tip, where there are a few blackish hairs. Legs and feet silvery-grey; nails white, covered by the hair of the toes, which extends beyond. When nearly grown, the young are colored as above, except that the upper part of the tail is blackish-brown. A specimen apparently only a month or two old, exhibits the same coloration, the hues, however, being generally duller.

The Arvicola Gapperi is the only known American representative of a group of meadow-mice which differ so essentially from the rest

of the family as to have been erected into a sub-genus called *Hypudæus.* Though the strongest distinguishing characters of this group are to be found in the teeth, skull, and other parts of the organization not apt to be noticed by persons unacquainted with anatomy, still, the external form of this species presents features strikingly different from any other of our known American meadow-mice, as in the large ears, pointed nose, and slender form. Some differences in its habits are not less remarkable. It is a Northern animal, its range, as at present ascertained, being from Nova Scotia, New Brunswick, Maine, and Massachusetts, westward to the Red River of the North. Near Breckenridge, Minnesota, at the south bend of the Red River, it is exceedingly abundant; but I did not observe it far north of this point; and it is rare, if found at all, as far north as Selkirk Settlement, in latitude 50°. It probably does not exist south of Minnesota, in the West, and has not been seen in Southern New York.

The red-backed meadow-mouse differs essentially in some of its habits from any other which has come under my observation. Our other species are remarkable for invariably forming well-worn paths under the leaves and grass, or even on nearly bare ground, in which they usually travel, rarely running on top of the leaves, or over the grass; and they are chiefly, though not strictly, nocturnal. But this species, on the contrary, appears to construct none of these paths, but habitually runs about and over the leaves and grass in any direction, like the white-footed mouse, *(Hesperomys leucopus,)* and is to a surprising degree diurnal. On the Red River of the North, I had repeated opportunities of witnessing these peculiarities. Near Breckenridge, I captured a number of this species, which, with several deer-mice, *(Hesperomys leucopus,)* came into a shanty to feed upon some rice which lay in bags on the floor. These arvicolæ never having been injured, were quite tame, and ran about the room without much regard for the presence of the occupants. In feeding, they sat upon the hind-feet and haunches, in the manner of the Arvicola austerus, holding the grains of rice with the fore-paw, and sometimes grasping a grain in one paw only. I did not at any time hear them utter cries as the Arvicola austerus does whenever several are feeding together, nor did they make any cry when caught. Neither did they enter traps baited with meat, and, though pieces of it were placed among the rice, they constantly declined such food. In climbing, they surpassed all other meadow-mice, running up the corners of the shanty to the roof, and over the rough logs as if perfectly at ease. In the woods, too, I found a nest in the rotten stub of a tree, several feet from the ground. They never moved by leaps, but trotted with a graceful, gliding movement, like the Arvicola austerus. I was particularly struck with their diurnal habits. Not only were they active during the day, but they appeared to seclude themselves strictly after dark. I caught them readily in traps, in the day, but never at night, nor were they seen in the evening, as would have been the case had they even been crepuscular, as at this time the Hesperomys leucopus entered the shanty while it was lighted, and ran over us throughout the night as we lay upon the floor, a number of them being caught in traps, but never

in the day. In several instances, I noticed the Arvicola Gapperi running about voluntarily in the woods in the daytime. The individuals thus noticed ran over the leaves and sticks, instead of around or under them, when slightly raised, like other meadow-mice ; and, when driven from their nests, they never attempted to burrow beneath the leaves, as is the habit of the Arvicola scalopsoides, in such cases. I sought in vain for any indications of regular path-ways under the leaves or grass, like those of our other species, and was finally induced to believe that it constructed none.

I found a number of the nests of the red-backed meadow-mice, and, with the exception of one placed in a stump, they were all situated on the top of the ground, under logs. They were slightly formed of a small quantity of soft leaves and grass. I observed no burrows; but for their winter residence, they probably dig them, and make large and warm nests, like our Illinois arvicolæ, like which also, they, doubtless, collect stores of food for winter consumption. It might naturally be supposed that in a climate so much colder than that of Illinois, the meadow-mice would dig deeper burrows and form warmer nests; but upon examining, late in September, the burrow of an arvicola, on the prairie near latitude 49°, where the mercury sinks to 60° below zero, I found it of about the same depth, and closely resembling that of our Illinois prairie meadow-mouse *(Arvicola austerus.)* The nest, too, was of about the same size, and several large excavations at the sides contained a store of winter provisions, to the amount of over a peck, consisting entirely of roots, chiefly those of liatris and helianthus, without any seeds at all. In this connection, I deem it worthy of remark that, in Illinois, the Arvicola austerus, which lives exclusively on the prairie, collects only roots for its winter store, while the Arvicola scalopsoides, which inhabits the woods, provides nuts, acorns, and small seeds, but no roots. Though this burrow was situated on a sand-hill, very scantily covered with grass, numerous well-trodden paths extended in various directions from it, over the nearly bare ground, to a distance of several rods. I did not capture the dwellers of this prairie burrow; but they were doubtless the Arvicola cinnamonca, of Baird, found at Pembina, near this same locality—a species closely allied to Arvicola austerus, and probably possess- ing similar habits.

The Arvicola Gapperi is, apparently, very prolific. I found eight young in a nest, and within several rods of this a family of five or six, probably a month or two older, and which I concluded to be an earlier litter of the same parent. The females have eight mammæ ; one I caught appearing to have had them all recently sucked. Though I collected several specimens of this species, together with a great number of Jaculus labradorius, drowned in a hole half a mile from the woods, I saw none on the prairie at any other time; whence it is inferred that they are probably confined to the woods. Near Breckenridge, I found them most numerous in a low heavily-timbered "bottom," though they were also common on high ground. In this "bottom," they were more numerous than I have seen any other mammal in an equal area, except the Arvicola austerus in Northern

Illinois. In the same locality, I observed the Hesperomys leucopus in numbers exceeding any I had seen elsewhere. When Minnesota shall have become settled, this meadow-mouse will probably prove as troublesome to farmers as our more southern species now are.

CANADIAN PORCUPINE.

Erethizon dorsatus, LINNÆUS.

DESCRIPTION.—This singular animal is about 29 inches in length, from nose to tail, when fully grown, and the vertebræ of the tail about 7 inches. The size is variable, many individuals being smaller. The body is thick and clumsy; the legs short, with broad feet and strong nails; the head is also short, with a broad nose, large incisor teeth, small eyes, and concealed ears Its general color, above and below, is brown or black, though sometimes lighter. The entire upper part of the body, head, legs, and tail are covered with long, coarse hair, intermingled with numerous tough, horny spines, or quills of various sizes and lengths, which are white, tipped with brown or black, with a few of the longest entirely white, those on the forepart of the head being less than an inch in length, and often 4 inches on the haunches, while those on the tail are of the greatest diameter. These quills are sharp and pointed at the extremity, where they are covered with numerous short barbs, or reversed points. On the under part of the body, which is clothed with long hair and fur, there are no quills. The hair on the back and sides is long, being sometimes 6 or 8 inches, and when the quills are erected, the animal presents a shaggy appearance, which makes it seem larger than it in reality is.

The Canadian porcupine is found throughout the northern parts of the United States, as far west, at least, as the Mississippi, and northward to the barren tracts, in latitude 67°. It does not exist in the Southern States. I am not aware that it has been observed in Northern Illinois, though it is said to inhabit Whiteside county and the banks of the Illinois River. It has been common in parts of Wisconsin, Michigan, and Northern Indiana. It never inhabits the prairie, and probably is not found in "oak openings" or prairie groves. It is not fond of swamps and bottom-lands, but particularly resorts to hill-sides and ravines.

This animal is almost exclusively an inhabitant of trees, and, when discovered on the ground, it is apparently only passing from or to its retreat, seeming to climb with more ease than to walk. Indeed, it is the slowest on foot among our mammals. Its retreat is in a hollow tree, and at some elevation, though it is occasionally found in the bottom of the hollow trunks of standing trees, near the earth. Being chiefly if not strictly diurnal, during the day, it climbs into trees to eat the bark, buds, and smaller branches, which form its only food, at least in winter. Hemlock spruce, bass wood, and slippery elm constitute its favorite repast. Sometimes, an individual will strip away sufficient bark to kill a tree; and it has been stated that. during one winter a hundred trees have been destroyed by a single porcupine; moreover, that all the young trees on two or three acres of woodland have been killed by two or three of these animals. Usually, however, they are not so destructive, and in Western New York, I am assured, they rarely kill trees at all, though they greatly injure them. It is only in this manner that they interfere with the farmer.

As the forest becomes the home of man, the porcupine disappears, for the armor of quills, though efficient protection against the wildcat or the panther, is no security against the rifle.

The quills of this animal are but slightly attached at the roots, and are erected at pleasure. Being sharp-pointed, they readily enter the flesh of their enemies, and are then immediately separated from themselves. Having once entered living flesh, every movement of the muscles causes them to penetrate deeper, the barbs preventing their extraction, even at first, without considerable effort and much pain. When attacked by another animal, unless near its retreat, its sluggish movements would render useless any attempt at flight, and therefore it curls itself up, drawing its unprotected nose and feet under the body, and presents to its assailant a rounded mass of bristling spines. At the same time, it is prepared to deal severe side-blows with its tail, which is armed with the strongest and most formidable quills—the tail, in fact, being the animal's chief weapon. Wo to the dog or wildcat that pounces on it now, for head, mouth, and feet are sure to be filled with the sharp-barbed quills, which always produce great agony, and frequently death.

The Indians and hunters eat the flesh of this animal, but to a more refined taste it would be unpalatable. The quills are much used by the Indians for the purposes of ornament, and are skillfully dyed in bright colors. Baskets and various other articles, formed chiefly of birch bark, are trimmed with them, and sold in considerable quantities in our cities.

A gentleman of Claremont informs me that, according to his observation, the porcupine produces from two to four young at a birth, and there is probably but one litter in a year.

In California, and northward on the Pacific coast, as well as along the eastern side of the Rocky Mountains, on the Upper Missouri, this species is replaced by the yellow-haired porcupine, *(Hystrix epixanthus,)* of Brandt.

SHREWS.

The family of shrews is composed of small animals having considerable external resemblance to mice, for which they are frequently mistaken by careless observers. They are numerous in North America, and species have been found in Europe, Asia and Africa; but none, thus far, in South America. Twenty North American species are given in Baird's Report on Mammals, and many, yet unidentified, doubtless exist. Shrews are properly insectivorous, their teeth being formed for seizing and crushing insects, and their organization otherwise adapted to this purpose. They are remarkably voracious; therefore deserving the attention and kind treatment of farmers, who, however, uninformed of their habits, too often kill them indiscriminately with mice. Shrews are chiefly nocturnal—some species aquatic. None hibernate, and all are capable of enduring an extraordinary degree of cold. The young, at birth, are naked and blind.

The body of the shrew is slender; the legs short, the feet and nails resembling those of a mouse; the neck is short and powerful, and the head stout, terminating in a long, pointed nose, extending much beyond the teeth, the slender, but strong, cartilaginous point of which is movable. The eyes are exceedingly minute, and are usually hidden by the fur. The lower incisor teeth project horizontally forward from the jaw, at the base, and are curved upward near the tip. The points of the teeth are usually of a dark color; the body is densely clothed with soft glossy fur. On each side, are glands, which secrete a fluid of peculiar odor. These glands are more fully developed in the males.

No mammals of equal abundance are so little known as the shrews. Not only are they almost overlooked by farmers, but the most eager naturalist is baffled in his attempts to learn fully their habits, and often even to secure specimens. Leading chiefly a nocturnal and subterranean life, and being shy and wary, they are seldom met with even where most numerous.

SHORT-TAILED SHREW.

Sorex Blarina (brevicaudatus,) SAY.

DESCRIPTION.—This is the largest North American shrew known. It is of compact form, with the head broad and massive, and the ears small and perfectly concealed by the fur. The tail is short, about as long as the head. The dimensions of an adult male, in inches, are, from nose to tail, $3\frac{1}{2}$; tail to end of vertebræ, 1; tail to end of hair, $1\frac{1}{4}$; hind-foot, $\frac{9}{16}$; extent of snout beyond the teeth, $\frac{3}{16}$. The dimensions of another are, nose to tail, $3\frac{5}{8}$ inches; vertebræ of tail, 1. Of a third, the dimensions are, nose to tail, $3\frac{1}{2}$ inches; vertebræ of tail, $\frac{7}{8}$. In life, the snout is flesh-colored; the naked tip, which is lobed, has the lobes of a brownish-drab color. The teeth are tipped with brown, deepening into glossy dark-brown at the points of the incisors. The minute black eye is visible in life; tail, cylindrical, much constricted at the root, where it is naked, flesh-colored, thinly clothed with short leaden-brown hairs, lighter on the under surface; feet, lighter flesh-color, more thinly clothed with light brownish-drab hairs; toes, still lighter and nearly naked, the hairs not covering the nails, which are whitish, faintly tinged with flesh-color; whiskers, less than half as long as the head, all bright whitish-drab. The fur of the body is dense and soft, plumbeous at the base, tipped with glossy leaden-brown on the back, and lighter on the belly, where there is somewhat of a dull rusty tinge. Viewed from behind, the back appears black; from before, bright leaden brownish-drab. In dried specimens, the flesh-color of the snout, feet, and tail fades to whitish, the tip of the nose remaining brown.

There is some question as to whether the small group of very large short-tailed shrews, including Sorex brevicaudatus, Sorex talpoides, and, perhaps, Sorex carolinensis, are not all identical. Should the Sorex talpoides be really distinct, it will probably be found that the shrews of this type in the Eastern States and Canada are Sorex talpoides, while those of the Upper Mississippi Valley, and west to Nebraska, are Sorex brevicaudatus. Assuming the short-tailed shrew to be distinct from Sorex talpoides, its geographical distribution, as at present known, is throughout Illinois and Southern Wisconsin, and west to Iowa and Nebraska. It is abundant in Northern Illinois and Southern Wisconsin. I found a specimen in Southern Illinois, and in the collection of the Northwestern University is one obtained

at Lebanon, Indiana. The close resemblance borne by some shrews to each other, together with the incompleteness of their history, and the rarity of specimens, make it difficult to trace their geographical distribution with any degree of certainty.

The short-tailed shrew abounds both in prairie and woods. I am unable to say whether it exists far out on the larger prairies; but it has been found in abundance several miles from any woodland. It is fond of high ground, and is not at all aquatic. I have been unable to find traces of it in wet places, such as swamps and the edges of sloughs, within a few rods of which it is numerous. I have nowhere seen more of its tracks than on some white-oak ridges lying several miles west of Lake Michigan. But even where most numerous, it is little known; and, indeed, it is no easy matter to get sight of one of them at any time. In turning over old logs, for hours, in search of them, I have rarely been able to see one; and then only when it was retreating at such speed as to generally escape in some of the numerous path-ways which lead in every direction from a log thus chosen for its resting place, or under which it may happen to take refuge on a journey by day. These, like other shrews, are often found lying dead on the ground, both in winter and summer, having been killed by birds or beasts of prey, and left uneaten on account of their disagreeable odor; and such are usually the only specimens observed by farmers.

In the woods, this shrew generally passes under the leaves, just at the surface of the ground, in search of food. In examining their tracks, I have frequently found where they inclined downward into the earth, several inches, or a foot, and even more, and then turning up to the top, and going on under the leaves again. In forming these passages, it had not dug out the earth, but pressed it aside, doubtless loosening it first with its snout, incisor teeth, and fore-feet; and in this manner, I observed caged specimens to burrow rapidly. When the course of the tracks under the leaves was obstructed by a stick, or the roots of a briar, or bunch of grass, it descended beneath instead of going round or over it. In spots of loose earth, many tracks were entirely under ground. In some spaces, several rods square, I have been unable to find a foot not crossed by the net-work of leaf-covered tracks of these animals, composed of large, well-beaten galleries, more than double the diameter of their bodies, frequently branching and intersecting each other, with innumerable side-tracks, which seem to have been less used. Under every log, where would be found the most abundant supply of insects, was a large passage, with a labyrinth of side-tracks. By the pile of excrement observed where some were discovered under logs in the daytime, it would appear that these are often chosen for resting places. The nest is probably in a burrow, at some distance below the surface. I have never seen one, nor do I know the number of young produced at a birth.

The preferred food of this, as of all other shrews, is slugs, earth-worms, and other similar insects; though it may, also, sometimes capture and devour young mice, reptiles, and birds. I have caught

it in traps baited with beef. Other shrews have been observed to eat grain while in captivity, and this species may do the same; but insects are always preferred to vegetable food.

I am not aware that shrews are ever accused of doing the farmer any considerable injury, while the benefits conferred by them in their destruction of insects are very great. If they ever injure vegetation at all, it is while searching for insects which would prove more destructive. They should always be protected. This species, though chiefly nocturnal, moves about in its path-ways more or less by day. Like other sorexes inhabiting the North, it can endure a great degree of cold, being active in the severest weather in winter, running about or through the snow.

I have several times kept specimens in captivity for a day or two, though they always died by the end of that time, despite my care. While alive, the minute black eye is distinctly seen and always open; but, though the sense of sight may be possessed in the dark, it certainly is not used in the full light. Upon waving different objects before one, or thrusting my finger or a stick close to its face, no notice was taken of it whatever; but if I made any noise near by, it always started. If the floor were struck, or even the air disturbed, it would start back from that direction. I observed no indication that an acute sense of smell enabled it to recognize objects at any considerable distance; but its hearing was remarkable. An exceedingly delicate sense of touch was exhibited by the whiskers, and if, after irritating a shrew, I placed a stick against it, in even the most gentle manner, the animal would instantly spring at it. I could see that, in running along the floor, it stopped the moment its whiskers touched anything; and often, when at full speed, it would turn aside just before reaching an object against which it seemed about to strike, and which it certainly had not seen. Unless enraged by being teazed, it endeavored to smell every new object with which its whiskers came in contact, turning its long flexible snout with great facility for this purpose.

My caged specimens, both male and female, exhibited great pugnacity. When I touched one several times with a stick, it would become much enraged, snapping and crying out angrily. When attacked by a meadow-mouse *(Arvicola scalopsoides)* confined in a cage with it, one fought fiercely; and though it did not pursue its adversary when the latter moved off, neither did it ever retreat; but the instant the mouse came close, it sprang at him, apparently not guided in the least by sight. It kept its nose and whiskers constantly moving from side to side, and often sprang forward with an angry cry, when the mouse was not near, as if deceived in thinking it had heard or felt a movement in that direction. In fighting, it did not spring up high, nor attempt to leap upon its adversary, as the mouse, but jerked itself along, stopping firmly, with the fore-feet well forward, and the head high. On coming in contact with the mouse, it snapped at him, and, though it sometimes rose on its hind-feet in the struggle, I did not observe that it used its fore-feet as weapons of offence, like the arvicolæ. Its posture, when on guard, was always

with the feet spread and firmly braced, and the head held with the snout pointing upwards, and the mouth and chin forward, in which position, its eyes would have been of no use, could it have seen. The motions of this animal, when angry, are characterized by a peculiar firmness ; the muscles appear to be held very rigid, while the movements are made by quick energetic jerks. Short springs, either backward, forward, or sidewise, appear to be made with equal readiness.

This shrew is quite active as well as strong ; the snout and head are powerful, and seem to be much used in burrowing ; the tough cartilaginous snout received no injury from the rough edge of a pane of glass, under which that of a caged specimen was forcibly thrust in endeavoring to raise it. When liberated, upon a smooth floor, it runs rapidly, without ever leaping, placing only the toes on the surface ; though in moving slowly the whole tarsi of the hind-feet are brought down. By placing an ear of corn, over 2 inches in diameter, at the edge of the room, and chasing a shrew towards it by striking the floor behind the animal, I have seen one several times spring over it, apparently without great effort; but if not much frightened, it would always go round objects an inch high, running close along them, as it did beside the wall, invariably feeling its way. One would never leave the side of the wall to run across the room, and would always run round the side of its cage, rather than go across the middle. When hurt or irritated, it uttered a short, sharp, tremulous note, like *zee–e*, and, when it was much enraged, this note became longer, harsher, and twittering, like that of some buntings or sparrows. Sometimes, a short, clear cry was uttered, the voice calling to mind that of the common mink, *(Putorius vison,)* but softer and lower.

COOPER'S SHREW.

Sorex Cooperi, BACHMAN.

DESCRIPTION.—This species is small, with the body slender, the head rather narrow, and the snout much elongated ; the tail is nearly as long as the body ; the feet very slender, and rather long; the ears large and visible; the upper part of the tail, and the upper surfaces generally, are light chestnut-brown ; all the under surfaces brownish-white. The dimensions of a specimen from Northern Illinois, from nose to occiput, were, $\frac{83}{100}$ of an inch ; nose to root of tail, $1\frac{83}{100}$ inch ; tail to end of vertebræ, $1\frac{1}{2}$ inch ; tail to end of hairs $1\frac{7}{10}$ inch ; length of hind-feet, $\frac{45}{100}$ inch. The dimensions of another from the same locality were, from nose to occiput, $\frac{82}{100}$ inch ; nose to tail, $1\frac{86}{100}$ inch; vertebræ of tail, $1\frac{23}{100}$ inch ; tail to end of hairs, $1\frac{39}{100}$ inch.

Cooper's Shrew has a wide range. It has been found from Massachusetts to Illinois, west as far as Nebraska, and north to Labrador and Minnesota. It exists as far south as Murphysborough, in Southern Illinois. It is not uncommon in the northern part of the State, and, though I have never seen it alive, I have obtained a number of specimens, which were found dead, on high land, at the edge of a wood. Of its habits, but little is known. My very limited observations, however, go to show that it is not aquatic, like some of the allied species; and it appears to inhabit both prairies and woods.

ARNOLD'S SHREW.

Sorex eximius, BAIRD.

DESCRIPTION.—Size less than two-thirds that of the Sorex brevicaudatus; form similar to the latter, but the body more slender; snout small and short, naked at the tip, distinctly lobed; feet small; tail small and short; ears small and concealed; fur of the body short; whiskers scanty and short. The entire upper parts are of a rich glossy-brown, the hairs being plumbeous, ringed with light brown near the ends, and tipped with a darker shade. The lower parts, fore-feet, and under side of the tail are of a bright silvery-grey; the hairs of the belly plumbeous at the base; the upper side of the hind-feet and legs are brown, like the back; the snout entirely dark-brown. Length from nose to tail, $2\frac{3}{8}$ inches; tail to end of vertebræ, $\frac{5}{8}$ of an inch; tail to end of hairs, $\frac{3}{4}$ of an inch; length of hind-foot, $\frac{7}{16}$ of an inch.

The general external form of this beautiful little shrew very nearly resembles that of the Sorex brevicaudatus, though it is scarcely more than half the size, and will at once be distinguished from the Sorex cooperi by its very short tail, small snout, concealed ears, and more slender body; and as readily from Sorex brevicaudatus, by its much smaller size, more slender feet, and light-colored belly. It may possibly be Say's Sorex parvus. The individual described very nearly resembles Audubon and Bachman's figure of that species. It was found in a prairie, three miles from the woods, De Kalb county, lying dead upon the snow. This species has also been taken near St. Louis, as well as in the woods at Independence, in Missouri.

SILVERY MOLE, OR WESTERN GROUND MOLE.

Scalops argentatus, AUDUBON and BACHMAN.

DESCRIPTION.—Length from tip of snout to root of tail, 6 or 7 inches; tail, 1 inch, or a little over; head stout, and neck closely attached to the shoulders, without the latter being visible; the cartilaginous and flexible snout extends nearly $\frac{3}{8}$ of an inch beyond the upper jaw; eyes not visible; no external ear, and the small ear-hole placed far back; fore-feet flat, of a comparatively large size, being nearly an inch in breadth and a little less in length, including the nails, which are large, flat, and slightly arched. The hind-feet are slender and weak, the soles of all the feet naked; on top, they are sparsely clothed with short hairs, as is the tail; the snout is naked at the tip, thinly clothed with short hairs further back The nails, feet, tail, and snout are of a light flesh-color, the nails tipped with white; the fur, which is dense, soft, and glossy, appears silvery-grey, and plumbeous on the surface, reflecting in different lights splendid tints of silver, purple, and bronze.

The genus Scalops comprises this and several other nearly allied species, all of which are confined to North America. They closely resemble the true moles, (talpa,) which are not found in America, being replaced here by these and the star-nosed mole (*Condylura cristata.*) The various species so nearly resemble each other that all are usually considered identical, even by the more observing of our farmers. The well-known ground-mole *(Scalops aquaticus)* of the Eastern and Southern States is a different species from that here considered; though, in their habits, as otherwise, they are nearly alike.

This species is found abundantly in parts of Illinois, Iowa, Mis-

souri, and Western Kentucky, as well as in Indiana and Michigan. Its range, as at present known, is from the last named State, west to Fort Riley, Kansas, and through the valley of the Mississippi, south to Louisiana. In the Atlantic and Southeastern States, it is replaced by the Scalops aquaticus. Though generally found throughout Illinois, it is rare in the extreme northern parts, and in the southern, appears to be equally abundant in woods and prairies, preferring, as far as I have observed, or can learn, the driest land, and never resorting to places which are wet.

The most striking feature of this animal is the extraordinary size of its fore-feet, which are attached to the robust shoulders by short and powerful legs, and worked by large pectoral muscles. Instead of being placed under the body, the feet are extended out at the sides, edgewise with the soles—or, perhaps more properly, palms, for they resemble hands more than feet—turned backward. For locomotion above ground, this is certainly not a convenient form; but it is by such a modification of organs, united with unusual strength, that the mole so readily ploughs its way through the soil; and, indeed, it seems to travel thus more easily than on the surface. In motion, the fore-feet are thrust forward at the sides, with the edge, answering to the thumb of a man's hand, placed downward, and the nails taking hold in the earth, the body is drawn along with ease and rapidity, as a row-boat is propelled by oars, the hind-legs carrying the posterior parts. Those I have observed burrowing through unbroken soil appeared to loosen the earth in front with the long snout, and then to thrust it aside with the fore-feet, by the same movement which carried the body forward, the ground being raised above by the upward pressure of its powerful head and shoulders. The snout was kept in constant motion, undoubtedly as much in search of food as to loosen the particles of earth for the passage of the body.

The eyes of these animals seem to be sightless. This might be regarded as an unfortunate deprivation, did we not consider of what little use the power of vision would be in their subterranean abodes. Their strength is astonishing when compared with their size.

The proper food of this animal, like that of all other moles, is principally insects, in search of which, it passes along just below the surface, raising the earth so as to form a ridge, whereby its track is readily traced in summer, when it does not usually go beyond 2 or 4 inches deep for food, except in very dry weather—the insects lying mostly near the surface. Its habits in winter are not well known, though it is certainly active at this time, when it doubtless travels readily below the reach of frost, in search of food, to which depth some kinds of insects then descend. It appears incapable of enduring much cold, however, and, though one has been known to come to the surface occasionally during thaws in winter, it is never observed to come out in severe weather, as its hardy relatives, the shrews, habitually do.

The nest of this species is of considerable size, formed of soft grass, leaves, &c., the materials being sometimes carried by the moles for several rods under ground. It is situated in a chamber from 6 to 10, and even 18 inches below the surface, and is commonly under a log

or stump, if in the woods. The chamber is approached by numerous converging galleries, some of which descend below the level of the chamber itself, entering it from beneath. Those roads which are most travelled by the moles are of larger size than those formed only in search of food.

When a mole is liberated upon the ground, it does not attempt to run, but digs directly down, and will bury itself in a remarkably short time. When one is alarmed, while burrowing, it digs deeper.

The number of young produced at a birth appears to be variable. The closely allied Scalops aquaticus was observed in one instance to bring forth five, and in another nine; and this species might be expected sometimes to be equally prolific. A gentleman of Winchester writes me that, in the latter part of February, he found a pair of moles, male and female, in their nest; and upon dissection, the female proved to be gravid with two young, fully formed, clothed with hair, and apparently about to be brought forth. A gentleman of Diamond Grove states that, as observed by him, the moles produce two or three young about the last of May; while at Beverly, Adams county, they have been known to produce four about the 1st of July. If these informants have made no mistake in their dates, this would indicate that at least two litters are produced in a year.

Though generally nocturnal, the mole is not strictly so, and may frequently be found moving by day, especially in cloudy weather, or early in the morning, or late in the evening. It doubtless travels still more by day in its deeper galleries, where the light can never penetrate. I have sometimes found it, in the daytime, lying under logs, where there was no regular nest, nor resting place.

As before stated, the natural food of this animal is insects. If it ever eats vegetable substances, in so doing it departs entirely from the means of subsistence to which its organization is best adapted. It is the opinion of most of our farmers that moles feed largely upon vegetables, while some do not even suppose they ever eat anything else. A large number of farmers, from various localities, who have kindly written me accounts of this animal, agree in affirming that it certainly eats corn, potatoes, &c. They state that, wherever it follows the rows of corn, as it sometimes does for rods, going direct from hill to hill, all the kernels are missing, or have the "chits" gnawed out; and, in potato-fields, the tubers are found gnawed in two, or with an end nibbled off, lying in the mole's tracks, while a large tuber is sometimes perforated in the construction of the gallery. It is stated that it has been necessary to replant corn-fields in consequence of their ravages.

It has been seen that most of our rodents occasionally depart from their natural food to eat flesh, as do some carnivora to eat vegetables: and we need not be surprised at the moles doing likewise. If these statements be true, the mole departs strangely from its common means of subsistence; yet it is not improbable that this injury is done by arvicolæ, which would be very apt to follow the mole's tracks. The abundance of insects round the roots of vegetables, and the softness of the earth in the rows, would evidently be sufficient inducement for

the moles to follow the rows, whether to eat the vegetables or not. It is certain that, in many instances, they are accused of the injury to plants actually done by meadow-mice, and, as the latter are frequently called "moles," it is impossible always to know which is meant, "Arvicola" or "Scalops."

Though I am inclined to think that moles do not habitually feed upon vegetables to the great extent usually supposed, I know, from personal observation, that, under some circumstances, they can be induced to eat roots when no other food may be obtained. In two instances, I observed specimens in confinement to eat sparingly of lettuce and potatoes. Neither lived more than two or three days, however; and several others, kept for a day or two in barrels of earth, in which were placed both softened and dry corn, with vegetables of various kinds, died without eating them, though insects were greedily devoured by another while in confinement. It is highly probable that moles never eat vegetables when they can procure a sufficient supply of animal food; they certainly could not, under any circumstances, subsist upon vegetables alone. A number of experiments with caged specimens would satisfactorily settle this question, which is really one of considerable importance to our farmers.

Whether it eats vegetables or not, the mole makes sad havoc among young plants of all kinds by cutting off the roots in its course while searching for insects. It will sometimes follow a row of small plants, destroying every one for some distance. Farmers assure me that they have known the mole's tracks to cause serious injury by starting little runs in heavy rains, which, in time, become bad gullies. The same has been remarked of the Eastern species.

But, in spite of their destructive habits, moles must be regarded as more useful than injurious to our farmers; and before any one kills them, where they are not exceedingly abundant, let him examine the matter well, and consider whether the noxious insects eaten by them would not destroy more than they, if allowed to increase, as they certainly would as soon as the moles should cease to keep them in check, by devouring the great numbers they require for food.

The European mole, the food and general habits of which resemble those of our species, though troublesome to farmers, and often persecuted on account of its destructiveness, is yet, by observing agriculturists, considered a very useful animal; and instances are related in which, after its extermination on certain farms in England, the noxious insects have consequently so increased that the tenants of such farms have petitioned for the return of the subterranean protectors of their crops, and a renewal of the breed. It is stated that the results of the mole's good offices are especially perceptible in pastures and meadows; and this is probably the case also with the American species. Hence, however destructive these may be in cultivated fields, they should never be disturbed in grass-land.

When, from their great abundance and destructiveness, it becomes necessary to exterminate the moles for a time on a farm, they can readily be trapped, caught in pit-falls, or in a crock of water im-

bedded under the pathway, or poisoned with arsenic or strychnine in pieces of fresh meat placed in their tracks. When these animals are injuring newly-planted corn-fields, furrows made both ways between the rows prevent them from proceeding so readily. This mode is often resorted to in certain localities, and is believed to be advantageous, as some farmers, who would otherwise neglect to plough their fields, are thus in a measure forced to do so, and, consequently, not only are the moles prevented from doing much injury, but the growth of the corn is materially assisted, the weeds killed, and numerous insects and eggs thrown out, where they will surely be found by birds above and moles below the surface.

STAR-NOSED MOLE.

Condylura cristata, LINNÆUS.

DESCRIPTION.—There is but one well authenticated species of this singular genus. The length of the head and body is 5 inches; tail, 3 inches; the general form of the body resembling that of the common mole. The fore-feet are also large and flattened, but longer and narrower, and the tail is much larger and longer than in the common mole. But the most remarkable characteristic, and one by which this animal is readily distinguished, is the ciliated extremity of its nose, from which it has gained its name. The cartilaginous snout is elongated like that of the common mole, and is terminated by a circle of long points, radiating from its extremity, like the spokes of a wheel from the hub. The body is clothed with dense soft fur, which is plumbeous at the base, tipped with brownish-black on the back, and a little lighter beneath.

This is nowhere a common animal. It is said to exist in all of the Eastern and Northern States, and is found as far west, in Illinois, as the Mississippi, and at Fort Ripley, in Minnesota. I am informed that it exists also in Michigan, and that it has been captured in parts of Northern and Middle Illinois. I learn, moreover, that, in Edgar county, where it is not very rare, it has been observed inhabiting the prairie.

The food and general habits of the star-nosed mole resemble those of the common ground mole, except that it is said to prefer low, swampy places, and not to excavate its galleries to so great a length as the other. A nest, containing three young, has been found under a stump. This is not so strong nor so good a burrower as the common mole, and is supposed to be less injurious.

THE MINK.

Putorius vison, AUDUBON and BACHMAN.

DESCRIPTION.—Length from nose to tail, 15 to 20 inches; from tail to end of hairs, $7\frac{1}{2}$ inches. General color dark chestnut-brown, with the tail nearly black; end of chin white.

The mink abounds throughout North America, from the Gulf of Mexico to the Arctic regions on the one hand, and from the Atlantic to the Pacific Oceans on the other. As it is sub-aquatic, its form is

suited to moving in the water. The feet are large and broad, with the toes somewhat webbed, and the body long, slender and compact, with its bones so heavy that, if killed in a stream, it will sink. It swims and dives almost as readily as the otter. It sometimes, either voluntarily or when pursued by dogs, climbs trees, although it is not properly a climber. In the midst of its ramblings, it often stops, raising itself upon its hind-legs, and looking around and snuffing the air, as if on a watch either for enemies or prey. It never hibernates, even in its most northern habitat. I know of instances, in winter, where minks kept up a communication from their burrows through hollow logs to the streams under the ice, and when disturbed left their nests and swam beneath it to some other hiding place, after the manner of musk-rats. They are chiefly nocturnal in their habits, although occasionally seen out by day in all seasons, and in pairing time the males are very active both by night and day.

Near the prairies of this State, the mink sometimes takes possession of the house of a musk-rat, after devouring or driving off the rightful inhabitants. It appears to be quite as abundant and as much at home about prairie ponds and streams as in the woods. It digs burrows on the dry ground near the water, frequently in old ant-hills, some of which were penetrated to a depth of two or three feet, and a foot or two below the surface of the ground. At the extremity of the burrow is a chamber a foot in diameter, in which is found a globular nest of soft grass, lined with feathers, constructed with considerable art, and entered by an opening on one side. In the northern part of this State, where the climate is more severe, the burrows are deeper, being sometimes eight or ten feet in extent, with the nest two feet below the surface. On the prairie, minks are also found living in burrows, often six or eight rods in length, on high ground, from which long galleries extend to the edge of a slough or pond. These galleries, however, are not formed by the minks, but by musk-rats, which dig them in order to place their nests beyond the reach of high water, and yet have subterranean communication with the stream. Though they frequently take possession of the burrows of the musk-rat, and sometimes those of the badger and skunk, when situated in suitable localities, they also excavate them for themselves, but of much less diameter. In the woods, the burrows are generally found under logs or the roots of trees near the water, and in rocky regions they burrow under rocks or stone walls; and I have occasionally discovered them living in the hollow of a fallen tree, or in the decayed roots of large trees growing in the water.

The mink is not at all gregarious, and does not even live in pairs. During the love-season, which occurs in February or March, according to the climate, the female is accompanied by one or more males; but after this, each lives alone, the males apparently wandering about the remainder of the year. The young are brought forth in April or May, usually to a number of five or six, though sometimes there are as few as three. They separate from the mother as soon as they are able to take care of themselves, and before winter each provides itself a residence. The female exhibits considerable affection for her

young, and when in danger does not willingly desert them. She carries prey to them for a time before they leave the burrow, as the remains of birds and mammals are often found in the nest. The adults, however, have the habit of conveying their prey to their retreats at all times.

The mink is strictly carnivorous, and never, to my knowledge, eats vegetables. Besides birds and mammals, it feeds upon fish and aquatic reptiles, but probably does not subsist upon insects to much extent. Though not so expert as the otter, it frequently succeeds in catching fish in shallow water. In the prairie sloughs it devours at times considerable quantities of cray-fish, tadpoles, and frogs; and when the smaller of these places become nearly dry from evaporation, and are quite alive with tadpoles, and occasionally with mud-fish and stickle-backs, in common with the musk-rat, the raccoon, and reptile-eating birds, it clears these muddy pools entirely of their unfortunate inhabitants, which have no way of escape. The mink, however, does not always confine itself to this kind of prey; for when once it has gained access to the farm-yard, stocked with young turkeys, chickens, and ducks, it far prefers taking up its residence near by, where, without the exertion of long journeys and hard chases, it can make a nocturnal feast of its favorite food—blood and brains. Though destructive, it is not usually so much so in the poultry-yard as the weasel or skunk; for often, at least, if not generally, it exhibits much moderation, comparatively, contenting itself with a single fowl each night. In pursuing its prey, it follows the track by scent, like a dog, as may frequently be seen in the snow where it is chasing a grey rabbit or a covey of grouse or quails, which, as well as many water-birds, with their eggs and young, it destroys. It also steals upon its prey, and seizes it by a spring, like a cat. When attacked by musk-rats or dogs, it fights with considerable courage, and is not easily killed. Its voice, which is a remarkably shrill, twittering squeak, not unlike that of a bunting, is only heard when hurt, or otherwise excited. When taken young, it makes an agreeable pet, often manifesting strong attachment, although it will bite if suddenly provoked. As another mode of defence, the mink possesses anal glands, which secrete a fluid of powerful and fetid odor, scarcely less disagreeable than that of the skunk. This, however, it cannot eject like the skunk. When fighting, this odor becomes exceedingly disgusting.

From the great fondness of the mink for the blood and brains of its prey, it would probably be found best to use these substances in baiting traps, or preparing poison for its destruction, as well as for weasels, skunks, &c. The head of a bird is thought to be the most successful bait for these animals in the woods. As the mink grows more cunning when living about the habitations of man, and generally takes up its abode under a barn, hay-stack, or some other such retreat, so that its dislodgement is almost impossible, one will sometimes prowl about a farm-yard for several weeks, bidding defiance to all attempts at its destruction, and nightly killing a fowl, if any be within reach. In such cases a dog is the only means of getting rid

of this troublesome guest; for though he can rarely kill it, he will probably so harass and alarm it as to drive it away. Sometimes, however, a dog is not sufficient to rid the premises of one grown bold by long residence. This species is readily caught in "dead-falls," but the weight used must be quite heavy, as the animal possesses great strength and tenacity of life. It enters almost any kind of trap in the woods, and doubtless could be easily poisoned.

The skin of the mink, with its beautiful fur, at present is so highly appreciated that it commands ten times the price it did a few years ago; and the fur-dealers no longer need sell it under fictitious names. Very fine dark colored specimens sometimes sell for $5 each, and even higher, when manufactured into caps, tippets, &c. As in most fur animals, the skin of the Northern mink is the most valuable, and the fur is only good when taken late in autumn, in winter, or early in spring.

COMMON WHITE WEASEL, OR AMERICAN ERMINE.

Putorius noveboracensis, Dekay.

Description.—Length from nose to tail, about 10 inches; tail to end of vertebræ, 5 inches, or about half the length of head and body; tail to end of hair, about 6½ inches. The outstretched hind-feet reach not quite to the middle of the vertebræ of the tail. In summer, the color is chestnut-brown above, the belly white, tinged with yellow; the edge of the upper lip white, and the end of the tail black for one-third of its length. In winter, at the North, it becomes entirely white, except the black tip of the tail. In the South, it does not turn white in winter, but retains its summer color. In Northern Illinois, in winter, it is white. As in all the true weasels, the body is long, slender, and cylindrical, with the neck long and stout, and the head massive and broad.

This species exists throughout the northern part of the United States, east of the Mississippi, at least, and perhaps further west. In California and Texas it is replaced by other species, which resemble it in appearance and habits. It is not found in the extreme South, and is believed only to exist in mountainous districts in any of the Southern States. It is common in Northern Illinois, and I have received a specimen taken at Duquion, in the southern part of the State. It has also been found as far southwest as Arkansas. There appears to be doubt as to whether it is found at all in Arctic America, as is generally supposed. The geographical distribution of animals like this is extremely difficult to trace, and it can only be fully effected by collecting specimens from the various localities which it inhabits, as any but educated observers must confound different species, when they so nearly resemble as do this and several other North American weasels. Every farmer, therefore, interested in having the animals about him investigated, should endeavor to assist in the work, by sending specimens to competent naturalists or scientific museums, where they may be identified, and the information gained thereby published.

A more fierce and cruel mammal does not exist in America than

this little weasel. The courage and sanguinary disposition of the panther are insignificant in comparison, having regard to the strength of the two. Without hesitation, the weasel attacks animals five or ten times its own size; and, not content with killing enough for food, wantonly destroys whatever life it can, leaving the flesh untasted, and only sucking the blood of some of its victims. It is far more cruel than the mink, which usually kills its prey for food alone; and actually seems to delight in murder. When a weasel has gained access to a poultry-yard, it will frequently kill every fowl within its reach in a single visit; and it is related that one has been known to destroy forty well-grown fowls in a night. Fortunately, however, this animal, even when abundant, does not enter the farm-yard so frequently as might be expected, appearing to prefer a free life in the woods to easy but dangerous feasts on domestic fowls. It is generally less apt than the mink to make excursions about the abodes of man. I have observed for several years the presence of a number of these weasels in a grove near a farm-yard well stocked with poultry, which they never appeared to enter, though repeatedly visited by minks and skunks. Indeed, I am inclined to think that, notwithstanding their occasional predatory inroads, they should not be killed when living permanently about meadows or cultivated fields, at a distance from the poultry; for they are not less destructive to many of the farmer's enemies in the fields. Meadow-mice are certainly the greatest pests among mammals in Northern Illinois; and of these the weasel destroys great numbers. I am informed that, upon the appearance of a weasel in the field, the army of mice of all kinds begins a precipitate retreat. A gentleman of Wisconsin related to me that, while following the plough, in spring, he noticed a weasel with a mouse in its mouth, running past him. It entered a hollow log. He determined to watch further, if possible, the animal's movements, and presently saw it come out again, hunt about the roots of some stumps, dead trees, and log-heaps, and then enter a hole, from which a mouse ran out. But the weasel had caught one, and carried it to the nest. Upon cutting open this log, five young weasels were found, and the remains of a large number of mice, doubtless conveyed there as food. Pleased to learn that his supposed enemy was in fact a friend, and his poultry being at considerable distance, the farmer spared the young ones, intending to continue his observations; but upon examination the next morning, they had disappeared, having probably been carried by the mother to a more secure retreat. I have frequently found the half-eaten remains of meadow-mice in their own burrows, or under corn-stacks, which had doubtless been destroyed by this weasel, or perhaps the smaller one *(Putorius cicognanii.)* It is surprising that an animal so large as this should be able to force its way into the burrows of meadow-mice; and yet it appears to do so without difficulty.

Stacks and barnfuls of grain are often over-run with rats and mice; but let a weasel take up his residence there, and soon the pests will disappear. A weasel will, occasionally, remain for some time in a barn, feeding on these vermin, without disturbing the fowls. But it

is never safe to trust one near the poultry-yard, for, when once an attack is made, there is no limit to the destruction. When the animal has entered stacks or barns, it has the curious habit of collecting in a particular place the bodies of all the rats and mice it has slain; thus, sometimes, a pile of a hundred or more of their victims may be seen which have been killed in the course of two or three nights.

The weasel preys largely upon the grey rabbit, pursuing it to its hole, and killing it there. Like the mink, too, it tracks its prey by the scent, so that the rabbit is lost if once he seek refuge in a burrow or hollow tree. It also captures many ground-squirrels by following them into their holes, and frequently succeeds in killing quails, and sometimes birds as large as the grouse. Insects are doubtless its principal food. Numerous experiments are said to have proved that this species can be used in the manner of the European ferret for driving rabbits from their haunts; and it is probable that it would be found serviceable in a state of domestication for destroying rats and mice. It is readily tamed and kept, making pleasant as well as useful pets when due care is exercised to prevent its attacking poultry. It would probably soon free houses of the troublesome Norway rat, as it could pass through every hole entered thereby.

Like all the family, the weasel is nocturnal, though in some instances it is seen hunting by day. It is very active, and one may sometimes be tracked in the snow through a journey of two or three miles, made in a single night. It is, however, more attached to a permanent residence than the mink. It is not at all aquatic, nor does it, to my knowledge, show any preference for the vicinity of water either to its hunting grounds or its retreat. It appears generally to prefer hilly and rocky regions. It is said not to burrow readily, but usually to take possession of the burrow of another animal, or to choose its retreat in some natural crevice among rocks, or in slight excavations formed by itself under trees. I have generally found it occupying the burrow of the common ground-squirrel, (*Tamias striatus*,) and have sometimes known it to live in hollow logs in summer. It often travels under snow, through pathways constructed like those of the shrews and meadow-mice; and I have traced these snow-covered ways for many rods, where the weasel had evidently been in search of prey. Some of these had been travelled repeatedly and for a long time, though few tracks were seen on the surface. In consequence of this habit, the presence of the animal is sometimes not noticed.

In its winter quarters, the weasel forms a large, warm nest, like that of the mink. Five young are commonly produced in the early part of summer; and these, I am informed, remain with the mother, or at least keep together in the same neighborhood till autumn, when they separate, and, like the mink, lead a solitary life, the males only joining the females in the pairing season. This is in the latter part of February, at which time the males are very active, wandering far from their burrows in search of the females. I cannot say whether this species ever inhabits the prairie at a distance from the woods.

It may be that all the weasels found living on the prairies of Illinois are of the smaller species, Putorius cicognanii. All the weasels identified with the Putorius noveboracensis, which I have observed, were taken in the woods. This species is not a tree-climber any more than the mink ; but it has occasionally been seen to ascend trees, and I am informed of a remarkable instance in which one was observed to pursue and overtake a ground-squirrel upon a tree.

Though so closely allied to the ermine of Arctic Europe and Asia, *(Putorius ermina,)* as to have been long considered identical with it, the fur of the present species is comparatively worthless ; and while great prices are paid for ermine skins, those of this species are seldom bought at all. Whether the fur would be as valuable if the animal inhabited the Arctic regions I cannot decide ; but as far as Selkirk Settlement, on the Red River of the North, in latitude 50°, I found the skins of closely allied species, Putorius cicognanii and others, were not purchased by the fur traders. It is stated that in 1829 the skins of American ermines were not considered by the Hudson's Fur Company worth the expense of collecting. I am informed that, when in winter colors, weasel skins are highly valued by the Blackfoot Indians for making "medicine bags," three skins being worth the price of a horse. I also learn from an early settler that he found them in use and much in favor by the Indians of Illinois, for the same purpose, and for tobacco pouches.

NATURE AND HABITS OF THE HONEY-BEE.

"The bee observe,
She, too, an artist is, and laughs at man,
Who calls on rules the sightly hexagon to form ;
A cunning architect, that at the roof
Begins her golden work, and builds without foundation.
How she toils ! and still from bud to bud, from flower to flower,
Travels the livelong day. Ye idle drones
That rather pilfer than your bread obtain
By honest means like these, look here and learn
How good, how fair, how honorable 'tis
To live by industry. The busy tribes of bees,
So emulous, are daily fed with heaven's peculiar manna.
'Tis for them, unwearied alchemists, the blooming world
Nectareous gold distils ; and bounteous heaven,
Still to the diligent and active good, their very labor makes
The certain cause of future wealth."—*Village Curate.*

The natural history of the honey-bee, from remote antiquity, has attracted the attention of naturalists, moralists, and divines, as well as the inquisitive minds of all denominations of men. The inconceivable instinct of this species, its uniform habits of industry and economy, its wisdom and sagacity, and the peaceful regularity which pervades the whole community, afford a subject most truly instructive and sublime. But few animals exhibit in their social life such admirable policy, being free from all selfishness and highly devoted to the promotion of their common welfare.

An extensive cultivation of bees would not only enrich the observer with lessons in natural history of a highly pleasing, instructive and elevating character, but, requiring only a comparatively small outlay of capital and labor, would undoubtedly result in the addition of millions of dollars per annum to the wealth of the nation, as the profits are estimated at from 40 to 100 per cent. It appears from statistics that Austria, in 1857, produced 66,000,000 pounds of honey, and 6,600,000 pounds of wax, valued in the aggregate at $7,000,000; and that in some parts of Germany, Poland, and Russia, bee-keeping forms occupation for a considerable portion of the rural population, in which they are to a great extent encouraged by their respective governments, in supporting schools and issuing publications expressly devoted to the culture of bees.

The object of the generality of persons who keep bees is profit, which might be greatly augmented were they properly managed and their lives preserved by superseding the cruel destructive system by a more rational conservative one. In order that this branch of industry may be successfully and profitably conducted, it is highly important that the apiarian, or bee-master, should be fully acquainted with the instincts, habits, propensities, peculiarities, or, in a word, the nature of these wonderful little insects. By knowing these, he will be enabled to improve their condition, and afford them facilities for collecting and storing their treasures in the greatest quantity and in the purest state. The following attempt, therefore, to supply the more important details in their natural history, although in some respects incomplete, it is believed may be relied on:

In every colony of bees there are three kinds—"queens," or females, "drones," or males, and "workers," or neuters, though strictly considered there are but two, the neuters being only females in an undeveloped state. In a swarm containing 20,000 bees, about 19,000 are estimated to be workers, 1,000 of them drones, and one remaining, a queen, who, in the strictest sense, is the mother and sovereign of the whole. From 4,000 to 5,000 bees will weigh a pound. In a state of Nature, they inhabit hollow trees and the clefts of rocks in the mountains, where they congregate in communities, propagate and rear their progeny, lead a social life, and work for one common interest. But man, coveting the produce of their labor, has reduced them to the condition of domesticated animals, and shares with them in the luxury which could not be obtained from any other source; hence multitudes of these insects are made subservient to his convenience, and by him are provided with tenements, called "hives," suited to their condition, which protect them and their young against the inclemencies of the seasons, as well as their honey from the depredations of other insects and rapacious beasts. A prominent trait in the character of bees is their unrivalled industry. So ardent is their native passion for flowers, and such their pleasure in making honey, that a young worker, on the very day of its birth, is seen in the field, passing from flower to flower, and loading its feeble legs with pollen or its stomach with the nectareous fluid. They labor from the dawn of day till evening, and never cease to collect honey

and wax as long as the weather or season is favorable and the source of supply at hand, building cells at night and on rainy days. With proper protection, this insect may be said to be a resident of any climate of the globe, as it is known to prosper in hollow trees in Canada and in the northern part of the State of Maine, where mercury will freeze in the open air, as well as at the equator in South America, where the thermometer stands at 80° in the shade during the year.

With kind treatment, when honey is proffered or when they are gorged with it, bees are docile and even affectionate in their disposition, and may be handled with impunity by their keeper, especially when his hands have recently been washed with a solution of honey or sugar and water, particularly at or near the time of swarming; but if irritated or approached with timidity, they will attack a person or an animal with great violence, pierce their stings into the flesh and inject a liquid poison, the virulence of which is sufficient, in some instances, to produce death.

Of the three kinds of bees inhabiting a hive, the *workers*, as has been shown, form almost the entire swarm. They are called "neuters" because they do not serve for the propagation of the species. To explain this singular fact in the order of Nature, it is thought that all the workers would have been females, like the queen, had not the eggs from which they were produced been deposited in cells too narrow to allow a proper development of their sexual parts. They are much less in size than the queens or drones, being about half an inch in length.

The working bee is no less admirable in the structure and form of its body than wonderful in its instinct or sagacity. It is perfect in proportion, and harmonious in the combination of its parts, all concurring to the design of its creation. On each side of its head is a large, round eye, sufficiently hard on the surface to be proof against injury from contact with the substances it ordinarily meets. When these eyes require cleaning, it is performed by the brush of the legs. The head is also furnished with two "antennæ," or horns, of delicate touch, by means of which they reciprocally obtain by feeling a knowledge of each other, their queens, as well as the young. It is by these simple organs that bees are guided in the dark, and are enabled to construct their comb and cells and to feed the young brood. It has a long tongue, proboscis, or trunk, curved at its lower end, for licking and sucking the honey, and two strong mandibles, or teeth, which enables it to construct the cells and combs, as well as to carry all obnoxious substances from the hive. It has four wings and six legs. The third pair of the latter is much longer than the others, each containing a triangular cavity lined with strong curved hairs, used for the purpose of holding and carrying to the hive the pellets, or little balls of pollen, which it gathers from the anthers of flowers. Thus, when a bee enters a flower the pollen adheres to its body, whence it is collected by the hairy legs into the form of a pellet, and deposited in the cavity for transportation to its home. At the extremity of each of the six feet are little fangs, with which they occa-

sionally attach themselves in clusters to each other, and to the sides of the hive. The abdomen is provided with two stomachs—the first, being only a simple bag, which is transparent, and, when filled, is of the size of a pea, containing nothing but honey, as it is collected from the fields, a portion of which is disgorged into the combs, to serve as a store for the future, whilst another portion passes for nourishment into the second stomach. At the extremity of the abdomen there is a sting, its weapon of defence, not consisting of a simple sharp-pointed instrument, but of two lancets, concealed in a director, and operated upon by muscles of uncommon strength, which to a casual observer would seem to be the sting itself. The external side of each of these lancets is provided with numerous arrow-shaped barbs, which prevent their retraction when pierced into the flesh, without great pain. When the retreat of the bee is hurried, or when the part stung is too firm, as the skin of man, the sting remains in the wound, and the bee thus injured only departs to die in a few hours. Notwithstanding the sting has become detached from the insect, it still retains its power of penetrating further into the wound. Again, the embarbed part of the sting is so finely polished that even with the best microscope no inequalities of surface can be discerned.

The usual term of life of the workers seems to be about a season, or six months, their places being quickly filled by the increase of young bees, which are of a light color when first hatched. These vary a little in size, probably on account of the irregular dimensions of the cells in which they are bred, a feature also observable in small drones that happen to be reared in workers' cells. This difference in size has misled some persons to the belief that there are different sorts of bees for various occupations, while it is maintained by others that working bees are "servants of all work," and that all of them are "equal to all occupations."

The principal duties of the workers are to collect and store away the honey, prepare the wax, and construct the combs, in addition to which they are ready to guard the hive, and even to sacrifice their lives for the general good. While some are gathering honey, others are searching flowers for pollen, which they bring home in the hollow of their legs. Some are diligently employed in the various works within the hive, as guarding the queen, constructing the cells, and attending to the necessities of the young, while others, again, keep constant watch at the entrance of the hive, where, if a stranger bee, a wasp, or a noxious insect appear, it is instantly repelled or destroyed. The singularity of the means which the Author of Nature has directed for the preservation of this species is particularly remarkable. In most other instances the mothers are the attentive and tender nurses of their young, but in this they only give them birth. This duty is committed to the workers, which manifest, as nursing mothers, as much affection towards the young as is observed in the real mothers of other animals. They prepare the cells appropriated for the brood of the three kinds of bees, and, after the queen has deposited her eggs, they supply the food for each kind, and seal their cells with a covering, differing in character according to the chrysalis enclosed.

Although bees will revel and roll in a flower, they collect no powder to store up, except what adheres to their bodies and legs. After depositing the pellets, merely by placing their legs in the cells, and quickly brushing off the pollen with their fore-feet, they again issue forth, almost as dusty as when they entered. The anxiety of bees to collect this substance is as great as their desire for honey; they eat no pollen, but cannot multiply without it—the one being as essential to the prosperity of the colony as the other.

Although the government of bees is strictly republican, it more resembles the monarchical, as a single individual, styled a *queen*, rules the whole. She is distinguished from the others by her form and size, being usually about twice as long as a worker, with a color tending to a deeper yellow, although queens vary in size, according to the cells in which they are bred, some being scarcely larger than the working bee. Her abdomen is longer in proportion, and its thickness is augmented when filled with eggs. Her legs are neither provided with bristles nor cavities, and her wings are much shorter than her body, in consequence of which it is somewhat difficult for her to fly. Her sting, which she seldom uses except when in combat with a rival, is strong, and bent at the end. Unlike other bees, a queen lives four or more years, and, what is more remarkable, seems to increase in size with age, a circumstance apparently at variance with the law that insects complete their growth in the nymph or pupa state. Thus she not only lives longer than other bees, but possesses a greater tenacity of life, being usually among the last to perish in a colony invaded by disease.

Much has been written in praise of the queen-bee, but she is less active than the workers, and is comparatively helpless without them. They certainly are greatly attached to her, still they do not pay her all the homage which some observers have supposed. She is seldom seen abroad, and seems to have no other functions than to engender and deposit eggs, animate and inspire the workers, and lead them off in swarms. A striking and cheering characteristic of social life is manifested by the faithful attachment and deep devotion of the workers to their sovereign. They neither tire nor relax in their attendance in providing for her comfort and security. They will crowd around her, and inquire, as it were, into her welfare, showing at the same time marks of reverence and sincere regard. If she manifests symptoms of indisposition, they appear to be greatly distressed, and if lost, and not replaced, the result will be self-abandonment, despair, and even death.

The queen lays all the eggs in a colony, let it be ever so weak or strong. She loves to propagate her progeny in secrecy at such a temperature of the hive as produced her own birth—90° F. The proper cells for the reception of the eggs are generally in the heart of the comb; consequently it is not easy to see the queen when thus employed. The eggs are quite small, elongated, slightly curved, of a brown color, and are deposited into cells adapted in size and shape to the kind of bee that is destined to occupy them. The queen, before she deposits an egg, examines whether the cell is clean and

suitable to its future occupancy, being aware which kind of bee will be produced from the egg she deposits. She lays profusely in the spring, less in summer, but little in autumn, and in winter not at all. She first deposits from 20,000 to 80,000 eggs for workers, one, or rarely two, at the bottom of a cell; and, as the combs are placed perpendicularly, the eggs, of course, rest in a horizontal position, and not on one side of the cell like those of wasps. She next lays, say from 500 to 1,000 eggs in the male cells, intended for drones; and, last of all, from 10 to 12 eggs in royal cells for queens. She always lays in the same order in respect to the kind of eggs, though they are less in number at every successive brood. Each sort is hatched in three or four days by the warmth of the hive, according to the season or climate, into "larvæ," or white worms, which lie in a curved position on the bottoms of the cells, surrounded by a thin, transparent fluid, or bee-bread, believed to be prepared from pollen, mixed with honey and water, which appears to be adapted to their age. As they advance in growth, they lie horizontally, with their heads towards the entrance, and repeatedly moult or shed their coats. After the larvæ are sufficiently large, nearly to fill their cells, say in about eight days, they prepare for another state, called "pupa," "chrysalis," or "nymph," during which they require no food. The workers being aware of this change, cover the mouths of the cells with a light brown wax. It may here be remarked that the cells, filled with honey, are provided with flat covers, while those containing the chrysalides are arched, and, in failure of the brood, fall in and turn black. The larvæ line their cells with a silky substance, which they spin after the manner of silk-worms, and make a kind of pod, or cocoon, in which they become completely enclosed. They now cast off their last coats as they enter the pupa state, and not a vestige of the old form is to be seen. How this curious change is effected is not easily determined. To bring it about, several parts must be removed, out of which, it would seem, new ones must be formed. When they are thus entombed, they are at first milky and soft, in which state they continue even after they assume the insect form, until they gradually harden and change color, and in about eight days more, at a trying moment, resulting in the death of many, break through their covering, and, without assistance, come forth perfect bees, the whole period of the metamorphoses occupying about twenty days from the time of depositing the eggs. As soon as the young bees emerge from their cells, they are wiped clean and presented with food by the workers, and in twenty-four hours after birth are capable of sallying forth into the fields, changing from a grayish or silvery hue to a yellowish-brown. The larvæ of drones are hatched in the same way as those of the workers; yet the time of their growth is somewhat less than that of the queens, which is usually about sixteen days. Although the queen lays an egg in each of the royal cells, which will successively be transformed into queens, only one in its mature state can exist long in the same hive. If two come forth at the same time, one must die for the welfare of the community. Nature, therefore, has inspired queens with the most

deadly hatred, which nothing but actual death can appease. They rush together apparently with great fury; the antennæ are mutually seized by their fangs. The head, breast, and abdomen of the one are opposed to the same parts of the other. The one which is either the strongest or the most enraged seizes the origin of her rival's wing with her feet; then rising above her, curves her own body, and inflicts a mortal wound. She then withdraws her sting, and quits her hold of the wing she had seized; and the victim down, drags herself along, and as her strength declines, she soon expires. During these combats the workers are in great agitation, but take no decided part in the contest, though they appear to be aware that it is necessary that such combats should be fatal in their issue.

The queen takes no part in the operations of feeding and nursing her young, this duty devolving entirely upon the workers. The greatest attachment is manifested towards the brood, the presence of which may be inferred from the collection of large quantities of pollen. During the periods of metamorphoses, the bees cluster around the breeding-cells, from which it is more difficult to drive them away than from those containing the honey. Indeed, the more brood there is, the greater the pertinacity or suspicion they manifest in guarding and defending the hive. If their sovereign, by chance, gets lost or removed, the whole hive becomes a scene of tumult and dismay. They seem to anticipate their own destruction; and if there be neither eggs nor larvæ for rearing another queen in the cells, their instinctive faculties will be lost, and in a short time they will disappear or die. But if there be brood in the cells, they will quickly pursue their labors, with the full assurance that Nature has endowed them with the power of repairing their loss, which they effect in the following manner: If there are no larvæ in the royal cells, they select one three days old from a working-bee's cell, and, after having sacrificed three contiguous cells, they form one adapted for a royal cell; and the larva which it contains is supplied with a peculiar kind of jelly, or paste, of a pungent taste, believed to be reserved for this purpose alone. By this process another queen is produced from a worm which otherwise would have been transformed into a worker; and thus, by a single metamorphosis, they obtain a new sovereign, and avert the effect of a loss that would have proved the utter ruin of the colony.

The *drones*, or male bees, have been abused by almost every writer on this subject; but without their concurrence with the queen, at the genial season, a colony would soon become extinct. They are larger and thicker than the workers, though similar in color, and are shorter than the queens. As they never visit flowers for collecting sweets, their probosces are shorter than those of the workers, and they require no strong hairs to brush off, nor cavities in their hinder legs to hold pollen, and accordingly have not been provided with them. They are known to be males, and are only useful in propagating their species, taking no part in the construction of the cells, in collecting the food, nor any interest in the economical duties of the hive, which they seldom leave except in the middle of warm days. Nothing sat-

isfactory is known of their real character or use, except that they fecundate the queen, but when or how this is done is not ascertained. Most apiarians are of the opinion of the Hubers, that this operation is performed in the air, and always results in the death of the drone. In cold and temperate climates, as the warm and milder season draws to a close, they are usually all destroyed by the other bees. Some writers recommend assisting the workers in their slaughter, but this seems needless; for their hatred is raised to such a pitch, that it extends, like that of the queens towards their rival nymphs, even to the larvæ in the drones' cells. It sometimes happens, however, that the drones are spared. In such cases, it is supposed that some misfortune has befallen the queen, and that their presence is wanted until another is bred. It also happens, though rarely, that drones are hatched late in autumn, which corresponds with their habit in tropical countries of repeatedly swarming during the year. The number of males in a hive, it will be remembered, is small, when compared with that of the workers, but should not be regarded as superfluous, as they come at a time of plenty, when their presence tends to keep up the requisite temperature in the hive to facilitate the hatching of the brood; in consequence of which, more collecting bees can be spared to attend to their duties abroad. The precise age to which drones will live is not known, but it is believed that they will often complete a period of six or seven months. Having fecundated the queen, they are destroyed at the close of the breeding season, for the sake of economy, by the workers, in a general carnage, which sometimes lasts seven or eight days. Being more sluggish in their movements, though much stronger than the other bees, and having no stings, they are unable to defend themselves, as they might otherwise do. As their bodies are covered with a scaly armor, they can only be wounded in their articulations and joints, which causes a great deal of trouble to their executioners, who may be seen dragging out the slain, or clinging to the wings of such as attempted to escape, piercing them to death with their stings.

Such is the order of Nature in the economy of the honey-bee, that, in spring or at the commencement of summer, there is thrown off from the parent hive from one to four *swarms*, or independent colonies of young ones, which, immediately after being domiciled, commence operations for themselves, or, if not molested or secured by artificial management, seek out a secure retreat in the fissures of rocks, in the hollow of trees, beneath the large branches, or, perhaps, in obscure parts of buildings not inhabited by man. Much doubt prevails respecting the cause which prompts bees to break off into these colonies. It is generally believed, however, that the want of space hastens the departure of the first swarm, which is led off by the old queen; but this cannot be said to be the case with the after swarms, as they come forth whether there is room or not. But rivalry of the queens has been assigned by others to be the primary cause; for, however crowded a hive, the queen will not quit with a swarm before more are in, or about to be in, the field to dispute her sway. It is true, that the old queen leaves a few days before her successors

appear, but she knows, of course, when to expect them. It may be remarked that working bees are taught by instinct the time they are to quit their hive, and occasionally sally out without the queen, but return as soon as they miss her. Indeed, they frequently have another home selected and prepared beforehand, especially the first swarms. In these, it sometimes happens that there are no drones, the appearance of which, with the clustering of the bees outside of the hive, are generally regarded as the first signs of swarming. This may be owing to the forward state of the young queens and the crowded condition of the hive. The almost unfailing precursors of swarming are these: For several days there is an unmistakable commotion in the hive; on the lighting-board, in front of the entrance, the bees cluster into masses, which are often of the size of a quart measure; and, at night-fall, retire again, as usual, within. On the following or the next morning after, if the weather is favorable—the sky cloudless—the confusion increases, and suddenly a column of bees hurry by a simultaneous movement into the air, and within a few moments assume a novel spectacle of thousands of these insects all on the wing, flying in whirls, until the mass resembles, in outline, a globe of 30 or 40 feet in diameter. During this exodus of young bees from their parental roof, all ordinary business appears to be suspended. The old bees dart to and fro, in a most angry manner, driving the young from the hive, if they attempt to return when the weather offers no hindrance to the success of their flight, and forcing them off by degrees from the place of their birth. The young swarm thus continue whirling over or very near the old hive, till all their associates have been assembled in the ring, when, apparently, with an unexpected start to the spectator, the whole body, unless arrested at this critical period, are lost beyond recovery. This, indeed, is the trying moment for the apiarian; for, if he is successful in obliging the bees to light, they at once can be secured in a new hive—which is no sooner accomplished than good order immediately ensues. First swarms are always the strongest, and the bees are well stocked with provisions to begin new structures. When they alight, they usually muster on the branch of a tree or bush near the hive, where they are readily taken, though at times they fly directly to an empty hive in the neighborhood, or to the hollow of a tree or the cavity of an old wall at a distance of a mile or two off. So much do they prefer a place of their own choosing, that they will sometimes quit a hive when their owner imagines he has them secure. The old stock may be said to be without a head for from six to nine days, according to circumstances—until another queen is hatched. It is then that she begins to attack her rivals in the cells, and utters the shrill sound. *peep, peep*, while the imprisoned ones cry *off, off*. This is termed "calling" the queen, and the evening is the best time to hear these significant sounds, which continue night and day, until one or more rivals appear. Then the general uproar ensues in the hive, and another swarm comes forth, perhaps on the third day after the sound began. The same process goes on with the next, which is smaller in number, and at a shorter interval, corresponding with the period between the

laying of the queen's eggs and the state of the weather, or the temperature of the hive. The succeeding swarms, it is well known, have not the strength and instinct, nor the care to select for themselves a future place of abode, like the first ones; and if not disturbed, will sometimes begin comb-building on a hedge or the branch of a tree or shrub. In connection with this subject, it may be stated that young bees seldom sting at the time of swarming, as they have no stores to defend.

An inspection of the internal arrangement of a bee-hive produces in the observer the highest degree of admiration. He beholds a city in miniature, divided into regular streets, which are lined with houses constructed on exact geometrical principles, and most symmetrically planned—some serving as store-houses for food; others, as the habitations of the citizens; and a few, much more extensive than the rest, destined for the palaces of the sovereigns. He perceives that the substance of which the whole city is built is one which man, with all his skill, cannot fabricate; and that the edifices thus formed are such as the most ingenious artist would find himself incompetent to erect.

Those who have seen a honey-comb must have observed that it is a flattish cake composed of a vast number of cells, for the most part hexagonal, regularly applied to the side of each other, and arranged in two strata or layers, placed end to end. Those intended for workers are hexagonal and horizontal, about an eighth of an inch in diameter, and six times as deep as they are wide; those for drones are also horizontal, somewhat irregular, and larger; but the royal cells, or the departments for queens, are circular, still larger, and arranged perpendicularly in the comb. The interior of a hive consists of several of these combs fixed to its upper part and sides, arranged vertically at a small distance from each other, so that the cells composing them are placed in a horizontal position, and have their openings in opposite directions. The distance of the combs from each other is about half an inch, that is, sufficient to allow two bees upon the opposite cells to pass each other. Besides, these vacancies, which form the main streets of the community, the combs are promiscuously pierced with holes, which serve as posterns for easy communication from one to the other without losing time to go round. The arrangement of the combs is well adapted for its purpose, but it is the construction of the cells which is most admirable and astonishing. As these are formed of wax, which is of no great abundance, it is important that as little as possible of such a precious material should be consumed. Bees, therefore, in the formation of their cells, have to solve a problem which would puzzle some geometricians, namely:

A quantity of wax being given to form of it similar and equal cells of a determinate capacity, but of the largest size in proportion to the quantity of matter employed, and disposed in such a manner as to occupy in the hive the least possible space. Every part of this problem is practically solved by bees. If their cells had been cylindrical, which form seems best adapted to the shape of a bee, they could not have been applied

to each other without leaving numberless superfluous vacuities. If the cells were made square or triangular, this last objection, indeed, would be removed; but besides that a greater quantity of wax would have been required, the shape would have been inconvenient to a cylindrical-bodied insect. All these difficulties are obviated by the adoption of hexagonal cells, which are admirably fitted to the form of the insect, at the same time that their sides apply to each other without the smallest vacancies. Another important saving in materials is gained by making a common base serve for two sets of cells. Much more wax as well as room would have been required had the combs consisted of a single stratum only. But this is not all. The base of each cell is not an exact plane, but is usually composed of three pieces in the shape of a rhombus, and placed in such a manner as to form a hollow pyramid. This structure, it may be observed, imparts a greater degree of strength, and still keeping the solution of the problem in view, gives the greatest capacity with the smallest expenditure of material. This has actually, indeed, been ascertained by mathematical measurement and calculation. Maraldi, the inventor of glass hives, determined, by minutely measuring these angles, that the greater were 109° 28′, and the smaller 70° 32′; and M. Réaumur, being desirous to know why these particular angles are selected, requested M. Kœnig, a skillful mathematician, without informing him of his design, or telling him of Maraldi's researches, to determine by calculation what ought to be the angles of a six-sided cell, with a concave pyramidal base, formed of three similar and equal rhomboid plates, so that the least possible matter should enter into its construction. By employing what geometricians denominate the *infinitesimal calculus*, M. Kœnig found that the angles should be 109° 26′ for the greater, and 70° 34′ for the smaller, or about two-sixtieths of a degree, more or less, than the actual angles made choice of by bees, a surprising agreement between the solution of the problem and actual measure! The equality of inclination in the angles has also been said to facilitate the construction of the cells. Besides the saving of wax effected by the form of the cells, the bees adopt another economical plan suited to the same end. They compose the bottoms and sides of wax of very great tenuity, not thicker than a sheet of writing paper. But as walls of this thickness at the entrance would be perpetually injured by the ingress and egress of the workers, they prudently make the margin at the opening of each cell three or four times thicker than the walls. Moreover, the sides and bottom of each cell are actually double, or, in other words, each cell is a distinct, separate, and, in some measure, an independent structure agglutinated only to the neighboring cells; and when the agglutinating substance is destroyed, each cell may be entirely separated from the rest.

It is not precisely known how long the combs will hold good, for this is a very different thing from the longevity of the bees. It is thought by some, however, that they soon wear out, owing to the cell-walls being thickened by the coatings of shells left by the nymphs; but when the hives are kept dry, they have been known to last fifteen

or twenty years. This shows that much may be gained, if the combs are good, in putting fresh swarms into deserted hives. Those who object to this should bear in mind that in winter a large portion of the combs are unoccupied by the bees, and therefore will remain unharmed.

Although some authors pretend to have revealed the mystery of comb-making, it may be safely stated that the manner in which bees construct their cells is unknown, except that they are made of wax, which is secreted in a form of an exudation, through the segments, or rings, beneath their bodies, and subsequently hardens into scales. Starting at the top of the hive, immediately after their settlement, they begin their first comb, which, when not more than half the size of a man's hand, may already contain both a little honey and a few eggs. Then, another and another comb are begun, the centre ones always being in advance, until the whole number reaches to within half an inch of the bottom board, or floor, space enough being left for ventilation and the entrance and egress of the bees to and from the combs. A common hive may contain seven or eight divisions of comb, generally arranged parallel to each other, which a strong colony, under favorable circumstances, will construct in two weeks.

Besides the wax, the bees make use of another substance collected from resiniferous trees, and called "propolis," or bee glue. It is more tenacious, of a resinous and glutinous nature, a reddish-brown color, and of an agreeable aroma, especially when heated or rubbed. This matter is employed for fastening the combs, stopping the crevices in the hive, excluding insects, moisture and light. Being elastic, it will expand on warm days when the wood of the hive opens from the effect of the heat, but in frosty weather it contracts and hardens like resin.

During summer, and sometimes until late in autumn, the workers are engaged in collecting or preparing another substance called bee-bread, which is of a reddish-yellow or pale color, varying according to the flowers from which it is obtained, and is thought by some to be a peculiar kind of pollen, while others suppose it to consist of the ordinary pollen combined with honey, elaborated, perhaps, through the agency of water, by some unknown process by the bees. As before observed, it is gathered and deposited for the especial purpose of supporting the young larvæ while helpless in their cells. Combined with heat, it is this material which discolors the much-admired works of the bee—rendering the wax and honey yellow, and, in time, the whole combs black. Besides, where this substance is stored by the workers, there, or in that part of the hive, will the queen lay her eggs—and there, of course, are propagated her young. And as animated Nature advances to perfection, so rises the interior temperature of the combs, say from 90° to 120° and even to 130° F., or until an almost suffocating heat obliges the tenants to leave their homes.

Honey, which seems designed by provident Nature to please the palate and mitigate distress, consists principally of the richest extract collected by bees from the cavities and petals of flowers, although

it is sometimes gathered, in the form of honey-dew, from the leaves of trees and shrubs, at a period of drought, or in autumn when there are few flowers in bloom. A portion of the honey received by the bee into its "honey-bag," or first stomach, is passed into the second stomach, while the surplus is disgorged from its mouth into the cells for sustaining the colony in winter or during rainy days. They commence by filling the upper part or rear of the hive first, on account of their remoteness from the entrance, which affords a greater security from pillage by other insects or swarms. During severe cold weather, say at a temperature in the hive of 40° F., or lower, it has been asserted that they exist nearly or quite in a state of torpidity, and eat very little, if any, honey. As it is the nature of these insects to maintain an interior warmth of 60° or 70° and upwards, to invigorate and cause an increase of population, it is necessary that they should consume a considerable amount of honey in order to produce that degree of temperature by their animal heat. Again, at 60° and above, they require much less honey to keep up the internal warmth of the hive than below that degree, the drones being then adequate to the discharge of this essential function; and during the hottest weather in summer it is believed that they necessarily consume but very little honey for that purpose.

In the opinion of modern writers, honey, while in the stomach of the bee, does not undergo any elaboration with other substances, but is disgorged through the mouth in the same condition as before it was swallowed. The best sort is of a thick consistence, and whitish color, inclining to yellow, possessing an agreeable smell and a pleasant taste. Those kinds collected from the flowers of lavender, white clover, and mignonette, are delightfully fragrant, and are produced by these plants in great abundance; the flowers of the two latter continuing in bloom during summer and autumn, and affording both pollen and honey the whole season. That made from the blossoms of the raspberry, whortleberry, and buckwheat, is peculiarly grateful, although the latter is objected to by some on account of its dark color, and in not being quite so pure and fine. The famous Hyblæan honey of the ancients, it is stated, was the essence of the flowers of the marjoram, (*Origanum vulgare,*) and thyme, (*Thymus serpyllum,*) which grew wild in great abundanee. It is no less singular than true that, while one kind of honey is of the finest flavor, delicious to the taste, pure and transparent, another is of an entirely different consistence, dark and greenish in color, tenacious and bitter; and that a third variety has been known to produce deleterious effects which, in some instances, seriously endangered human life. The rhododendron, which was known to the ancient inhabitants of Pontus, who were well acquainted with the poisonous qualities of its flowers, had such influence on the honey of the country that the Romans would not receive it in tribute, but required the Greeks to pay them a double portion in wax in lieu of it. The honey from the Azalea pontica, which grew in the same regions as the rhododendron, possessed similar properties. The flowers of the American rose bay (*Rhododendron maximum*) are likewise known to produce unwholesome honey, as well as

those of the great laurel, *(Kalmia latifolia,)* the dwarf laurel, *(Kalmia angustifolia,)* and the Jamestown weed, *(Datura stramonium,)* all of which should be extirpated from the vicinity of establishments devoted to the culture of bees.

There are three periods of the year in which those who keep bees may take the honey, but it is seldom taken more than twice, and generally but once; namely, in May or June, July or August, September or October. That taken in these seasons will be found to vary extremely in quality, and therefore should be kept apart. Of these, the spring honey is by far the best, and should be the only kind used medicinally, as the bees are in full vigor when they collect it, and the flowers from which it is gathered are in their most perfect bloom. Next in value is summer honey, while that of autumn is poor and weak, and will soon spoil.

Some persons object to keeping bees because they injure flowers, pierce fruits, and are apt to sting. It is said also that they perforate tubular flowers to get at their sweets—a charge denied by Nature in not providing the bee with a suitable instrument for the performance of such an act. The blame, with propriety, could be laid on the humble-bee, which, if it cannot reach the honey by the natural opening of the flower, will often make an aperture at the base of the corolla, or even in the calix itself, to insert its proboscis in the very place where the nectar is stored. It is true, that, in hot weather, when flowers fail, the honey-bee attacks fruit, or rather sips what is soft and passing to decay, or falling a prey to wasps; but, unlike the wasp and humble-bee, it seldom stings while in quest of food, unless harshly used. Instead of being injurious to vegetation, bees often render much service to the husbandman in assisting the impregnation of plants; and, possibly, we are indebted to them for many of the new varieties of fruits and flowers which we possess, by this very means.

As this branch of rural industry has been impeded in this country for many years by prejudices arising from the injuries supposed to be committed by bees in gardens, orchards, and vineyards, as well as the losses resulting from injudicious management, and the ravages of the bee-moth, an earnest appeal is here made to the interest and patriotism of the intelligent agriculturists and bee-keepers of the United States for their zealous co-operation in establishing and encouraging bee-schools and publications, with the view of improving and increasing the culture of this delightful pursuit. With a genial climate and a richly-varied vegetation, it may be successfully prosecuted on a scale corresponding to the expanse and fertility of our territory, and, with a due degree of knowledge and enterprise, it cannot fail to be another source of national wealth.

EXPLANATION OF PLATE II.

Fig. 1 denotes an egg magnified; 2, an egg as laid in the bottom of a cell; 3, a young larva at the bottom of a cell; 4, a full-grown larva; 5, a pupa; 6, a drone, or male (perfect insect;) 7, a queen (perfect insect;) 8, a neuter, or working-bee; 9, cells of working-bees;

10, cells of drones ; 11, cell of a queen ; 12, proboscis and mandibles, magnified ; 13, the sting and its appendages ; 14, the ovigerous tubes, spermatheca, and their appendages ; 15, the honey-bag, crop, or sucking stomach, and second stomach.

D. J. B.

INVESTIGATIONS ON THE INSECTS AND DISEASES AFFECTING THE COTTON PLANT.

BY TOWNEND GLOVER.

In pursuing the investigation of the characteristics and habits of the insects injurious or beneficial to agriculture, with the view of ascertaining how far they are destructive or advantageous to our crops, I feel called upon to give an account of some of the impediments and difficulties I have had to contend with since I entered the service of government, which I trust will be a sufficient apology for the apparent delay in making a final report. It is true, that, in the course of my rambles, I have experienced many of the pleasures incident to the life of a naturalist, while gazing with admiration and wonder upon the varied forms, colors, and motions of the insect tribes, or while noting their fecundity, modes of generation, metamorphoses, instincts, and distribution—the inimitable mechanism provided by Nature for locomotion, defence, and even for preparing themselves habitations, as well as for obtaining the food adapted to their habits, their mouths being constructed upon purely mechanical principles, in some instances having jaws armed with sharp penetrating hooklets for seizing and securing active and struggling prey ; keen-edged scissors for clipping and dividing the softer parts of plants and their fruits ; files, saws, and gouges for rasping, cutting, and excavating wood ; while in other cases they are provided with awls and lancets, for tapping the skin, and syphons or sucking tubes for imbibing fluids ; some devouring the leaves of vegetables or feeding upon grasses and succulent plants ; others destroying timber and the bark or roots of trees ; while another class, more delicately organized, is content in extracting the juices of the expanding buds, or in sipping the honeyed fluids from the cups of flowers. Again, many tribes are carnivorous, and so far are beneficial. Being armed with formidable weapons of destruction, they carry on a constant warfare with their own or other species, which they actually destroy by depositing their eggs in their flesh or on their skins, where they undergo the transformation peculiar to their race, feeding upon the rich juices of their bodies, thus exhibiting most beautiful illustrations of harmony, contrivance, and design. On the other hand, notwithstanding I have enjoyed these pleasures, I have encountered many hardships, difficulties, and dangers, in exposing myself to unhealthy regions, in sickly seasons, where I necessarily performed tedious journeys, in which I was steamed or scorched by the hot sun during the day, and drenched by

heavy rains or chilled by clammy dews at night, accompanied more or less by hunger and thirst, lassitude and disease.

In the course of my wanderings I was annoyed by gnats and flies which regaled themselves on my blood; irritated by ants, chigas, and ticks, that filled my skin or flesh with eruptions and sores; assailed with fury by bees and wasps that tortured me with their stings; and I was warned of my danger by the hiss and rattle of serpents that lay concealed along my path. These dangers and annoyances, troubles and trials, were alternated by pleasures, joys, and sudden delights which no one can realize except the lover of science—surely not the sordid slave of paltry pay. I have met with all kinds of treatment, adventures, and fares—generously welcomed under the hospitable roof of the intelligent planter, the true friend of enterprise and science, and have been approached and entertained by liberal and enlightened men, who neither appeared to understand nor to appreciate the object of my pursuit. And, allow me to add, notwithstanding all these vicissitudes, I have been amply compensated by the satisfaction I have received in making these explorations and in witnessing and describing the results.

Let the reader accompany me, if he please, to the vineyard, the corn-field, and the cotton plantation. On inspecting a sickly Catawba vine, near the base of its stem, in the month of July, by perforating the crown of the roots with a brad-awl or a pointed knife, we find imbedded in the bark and sap-wood a soft, whitish borer, or grub, measuring about an inch and a quarter in length. On further examination, we discover that this grub or larva has sixteen feet, but neither horn nor prominence on the anterior segment of the body, from which we are led to conclude that it belongs to the genus ægeria. The question now arises, What is this species? Is it the peach-tree borer, (*Ægeria exitiosa,*) the grape-vine borer, (*Ægeria polistæformis,*) or is it a new insect? In viewing other vines in the vineyard, we find the female of the Ægeria polistæformis, resembling a large bee or wasp, depositing her eggs just above the crown of the roots of another Catawba vine. We watch these eggs from day to day until they bring forth small whitish grubs, which soon after bore into and feed upon the bark of the vine at the lower end of the stem. Encouraged by this success, we proceed to examine the rest of the vineyard until we find another Catawba, resembling the preceding, but more sickly in appearance, with its fruit shrivelled and most of its leaves of a yellowish tinge, and some of them already fallen through premature decay. In digging into its injured roots, we find an oblong-oval pod or cocoon, about an inch and a half in length, formed of a gummy kind of silk, covered with fragments of wood, bark, and dirt, which we conclude is the chrysalis of this borer. The next step to be taken is to review what we have done, by collecting specimens of the larva or borer, the males and females of the perfect insect, the eggs, and the chrysalides, noting their characters, entering them in the Field-Book, and finally making accurate drawings of them all, of the natural size and colors. The labor of research does not end here; we place the eggs and chrysalides in a situation favorable

to hatching into larvæ and transforming into a perfect state, with the view of ascertaining the periods of metamorphosis. And yet the inquiry does not end ; a remedy or a preventive, if possible, must be sought for or devised. In noting the different species of vines, we discover that the Skuppernong is invariably healthy, and in no case is attacked by the borer either in the stem or in the roots. Granting this to be true, a remedy naturally presents itself by engrafting the Catawba and other varieties of the grape upon Skuppernong stocks in all localities where the latter will grow, the success of which will be obvious when we recollect that the insect attacks the vine only at the root.

Let us now turn our attention to the corn-field. On divesting several "roasting-ears" of their husks, we detect a number of worms, or caterpillars, measuring from a quarter of an inch to an inch in length, variously marked with spots and longitudinal stripes of different hues, feeding with great voracity upon the milky and tender grains near the apex of the cob. In watching these worms from day to day, we observe that they cast and renew their skins several times, until at last they attain their maximum size, when they cease feeding, desert the ear, and descend on the stalk of the plant into the earth, where, by constantly wriggling their bodies, they work out oval-shaped cavities adapted to their form and size. By gluing together particles of earth with a viscid gum, or silk, which issues from their mouths, the larvæ form rough cocoons, in which they shed their last coats, or skins, and change into glossy-brown chrysalides, or nymphs. On watching these produced from the early broods, we find that they are transformed into yellowish millers, or moths, in the course of a few weeks, which, from their characteristics, belong to the genus heliothes. We further learn, by observing these moths, that they deposit their eggs either on the silk of the young ears of the corn or upon the upper ends of the cobs, which reproduce small worms identical with those above described. In the meantime, specimens of these insects, males and females, which, so far as we know, belong to a new species, are collected in different stages of their metamorphoses, their characters and habits entered in the Field-Book, and accurate drawings of them made, as with the ægeria before described.

We will now repair to a neighboring planter's cotton-field, reputed to be badly injured by "rust." On examining the leaves of the cotton, we perceive that they are variously affected, some being changed to a bright yellow, blotched or blushed with red, marked more or less with brownish spots ; others exhibiting rusty-brown spots on their under sides, resembling incipient rust ; while a third class of leaves is curled up at the edges, the surface turned yellow, and in some cases fallen to the ground. Here we find a subject for investigation, which, perhaps, from its importance, may occupy public attention for years. The first is a case of genuine rust, as no marks of insect acts can be traced, even under the microscope, on any part of the leaves, and may require a long series of experiments to discover and avert, if possible, the cause. The second, on closer inspection, is found to be the work of a minute red spider, belonging to the genus acarus, which generally attacks the under side

of the leaves, puncturing them until they are stung and spotted all over, and finally fall from the plant. The third affection is caused by the cotton-louse, a species of aphis, which pierces the parenchyma or outer coating of the leaves, principally on the under side. From the constant drainage of the sap by this insect, the leaves are enfeebled, curl up, turn yellow, and subsequently fall. As the season advances, we observe that the young shoots of the plant are also attacked, and are often completely covered by these pests.

In watching this species of louse through its different stages of metamorphoses, we find that they are similar in character to other aphides, and are nearly of the same habits. The young are extremely minute, and of a greenish color; but when they become older, they increase to a tenth of an inch in length, and change to a dark green, and, in some instances, to almost black. The multiplication of these little creatures, it will be remembered, is almost incredible. Providence has imbued them with powers of fecundity which no other insects possess: At one period of the year they are oviparous; at another, viviparous; and what is most remarkable, the sexual intercourse of one original pair serves for all the generations which proceed from the female for a whole succeeding year, before the spermatic virtue of the ancestral coitus is exhausted. It has been proved that, in five generations, one aphis may be the great grand-mother and progenitor of 5,904,900,000 descendants, and it is supposed that, in a single year, there may be twenty generations. The impregnated ova, we find, are deposited in the axils of the leaves, either of the cotton infested by this species, or, perhaps, later in the season, on some neighboring object or tree, or, possibly, on the ground. By retaining their latent vitality through the winter, they are hatched by the warmth of spring, giving birth to a wingless, six-footed larva, which, if circumstances are such as to favor it with warmth and food, will produce a brood, or, indeed, a succession of broods, as before observed, without connection with a male. So far as is known, no winged females at this season have appeared; but after several generations from the virgin progeny, in the last larval brood, individual growth and development progress further than in the parent, and some of them become metamorphosed into winged males—others into oviparous females. By the latter, the ova may be developed, impregnated, and oviposited, and thus provision may be made for their dissemination and for continuing the existence of the species beyond the severe famine of the winter months. This double mode of reproduction will serve to account for the almost inconceivable increase of these insects.

Having watched and noted the changes and habits of the insect above described, and made miscroscopic drawings of the same—a labor of several months—we will next look about us and see whether there are any means provided by Nature to maintain the balance between the increase and destruction of this tribe. In prosecuting this inquiry, we find that the lady-bird, *(Coccinella?)* is a most valuable auxiliary to the cotton-planter, as it devours the aphides by thousands, and is always the most plentiful where the cotton-lice

abound. Again, we observe that the lace-wing fly *(Hemerobius?)* and a species of syrphus are constantly waging war against these lice. We also discover another fly, *(Ichneumon?)* wonderful as it may seem, deposits an egg in the body of a louse, which, hatching into a grub, devours the inside of the insect, while alive, until it eventually dies, clinging to the leaf, even after death, and the young fly escapes from the old skin of the aphis, and soon after commences her useful labors in depositing her eggs in the bodies of other aphides, in the same manner as her beneficent mother had done before her.

By the foregoing, the attentive reader will be enabled to form an idea only of a small portion of the duties I have had to perform, and the character of the scenes through which I have passed within the last few years; and to finish the important task I have commenced, he will be convinced, is only the work of time.

It may here be proper to state that, during the summer and autumn of 1854, I was principally engaged in the cotton-fields of South Carolina, Georgia, and Alabama, and the summer and autumn of the following year in those of Florida. The summer of 1856, I was detailed to Iowa, to investigate the insects of that State, and the autumn following was ordered to Demerara and Caracas to obtain cuttings of the sugar-cane, which I delivered in Louisiana in the early part of 1857. The summer and autumn of this year, I spent in Mississippi and Tennessee, examining the blight and rust in cotton, as well as the insects which infest this plant there. The only species of the latter I observed in these States, differing from those of the Atlantic cotton-growing regions, were a caterpillar, which appeared to do but little injury, and a wasp that I detected in the act of devouring the boll-worm.

A Healthy Cotton Plant.

First Stage of the Blight.

Among the enemies of the insects which attack the cotton-plant in Mississippi and Tennessee may be mentioned the mocking-bird, the bee-martin, or king-bird, the black-bird, and a species of lizzard, the latter being found usually in rotten fences, old stumps, and in hollow trees. The killing of these friends of the planter should be regarded

almost as sacrilege, and every possible effort should be made to preserve them, in order to check the prodigious multiplication of noxious insects, without which an inordinate accumulation would inevitably ensue.

The same diseases of the cotton that occur in the Atlantic cotton-growing States are usually found in Kentucky, Mississippi, and Tennessee, and at least one in addition, namely, a species of "blight," often miscalled the "rust," which is prevalent on the alluvial bottoms as well as on the uplands.

This blight appears very suddenly; as one day all of the plants of a field may seem to be perfectly healthy and vigorous, while on passing through the same field the next day, many of them may be observed with drooping leaves, as if affected by the heat of a mid-day sun. In a few days after, all the leaves will wither and fall to the ground, leaving the stem bare, though still green, and the ready-formed and, in some cases, fully matured opening bolls adhering to

Second Stage of the Blight.

Commencement of New Growth.

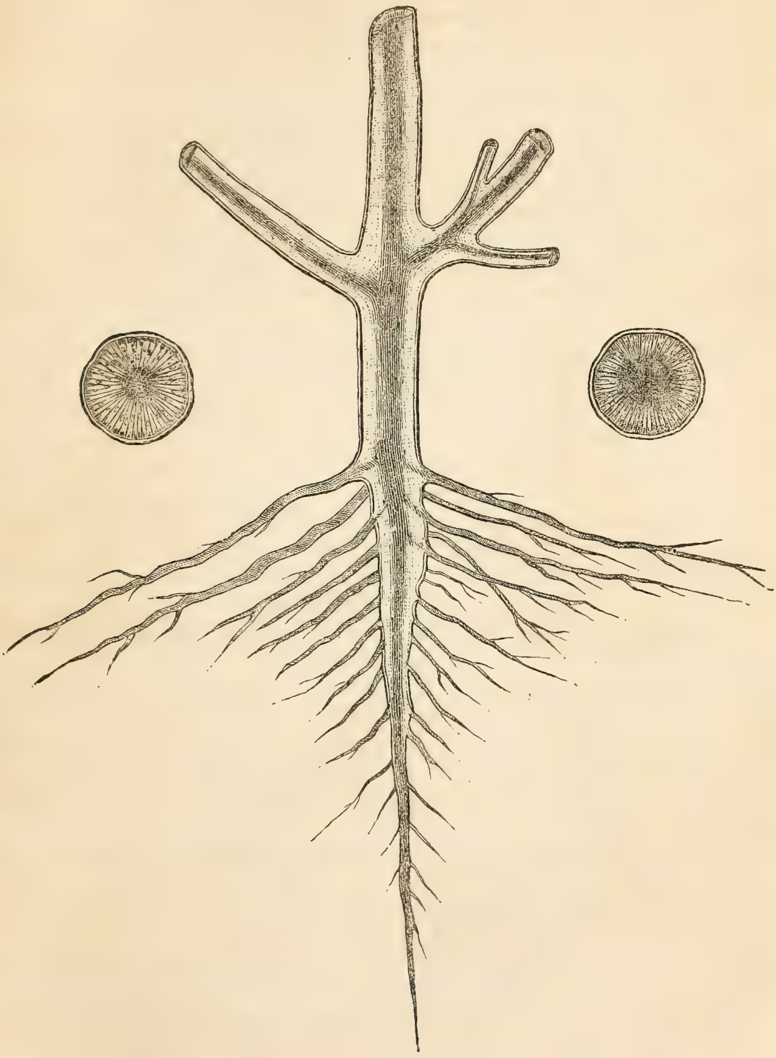
the branches. After remaining in a state of apparent lifelessness for some time, should rain and favorable growing weather follow, the affected plant will often send up suckers from the crown of the roots, and even, sometimes, young shoots from the junctures of the branches with the stem.

The difference between the rust and the blight is apparent at the first glance: In the rust, the leaves of the cotton turn yellow, and are often spotted or blushed with red. In the blight, they suddenly wither and droop, without changing to yellow as with the rust, turn brown and fall. The bolls also shrivel, dry up, aud the whole plant gradually dies.

As this disease was not observed by me before the middle of August, when it was at its full development, it is impossible to state how or when the young plants were first affected and began to show signs of disease. In pulling up an old blighted plant and dividing longitudinally the stem, I found that its pith and the heart of the main root, stem, and branches, presented a brownish or blackish appearance, as if the centre were rotten, which may be the proximate cause of the withering of the leaves.

On a close examination of the plants diseased, no insects, nor their punctures, could be observed; and as the blackened centres often

extend to the extremity of the branches and roots, it is obvious that the whole plant is in a state of disease, which, most probably, is caused by some vegetable acid in the soil, or, perhaps, by the tap-root penetrating into a hard, sour, or otherwise unfavorable sub-soil.



Sections of a Healthy and Diseased Stem, and of a Diseased Root.

In directing my inquiries to the effects produced by the rotation of crops in fields where cotton had been cultivated, I ascertained that, on one plantation in which the fields had been planted with cotton for five consecutive years, the first and second crops were perfectly healthy; the third, slightly attacked with the disease; the fourth, still more blighted; and that of the fifth year had large patches of blight,

ranging from a quarter of an acre down to a few yards square. On another plantation, on which cotton had been cultivated for several years in the same field until 1856, when one side was planted with corn and the other with cotton, and the whole field again planted with cotton in 1857, it was observed that the crop produced on the portion of the field planted with corn the previous year was vigorous and healthy, whilst that on the old cotton land was small and diseased.

Remarks on the Cotton Blight.—The suggestion thrown out by Mr. Glover, in the preceding paragraph, of the "blight" in the cotton-plant being caused by some vegetable acid of the soil, which probably had been left by continuous cropping, would admit of an explanation in M. De Candolle's theory on the "excretory functions of plants," whose views on that subject were opposed by Walser, but subsequently corroborated by Macaire, and more recently investigated by Professor Gasparrini. M. De Candolle, it will be remembered, was led to form a particular theory respecting the rotation of crops, founded on the hypothesis that the roots of plants were the seat of secretions of an especial nature, and that they are only parts of the juices, which, not having served for nourishment, are rejected when they arrive at the inferior parts of the vessels, and prove hurtful to the vegetation of the next crop, if it be of the same species or variety of plant, but may act beneficially on plants of a different nature; or, in other words, every plant, in ejecting all the moisture which extends to the root, cannot fail to eject also such particles as do not contribute to nourishment. Thus, when the sap has been spread by circulation throughout the vegetable, elaborated and deprived of a considerable quantity of water by the leaves, and then, redescending, has furnished to the organs all the nourishment it contained, there must be a residue of particles which cannot assimilate with the vegetable, being improper for its growth. M. De Candolle further asserts that these particles, after having traversed the whole system without alteration, return to the earth by the rootlets, and thus render it less suitable to sustain a second crop of the same family of plants, by accumulating soluble substances that cannot assimilate with it. In like manner, he observes, that no animal, whatever, can be sustained by its own excrement. Besides, it may also follow that even the action of the organs of a vegetable converts the mixed particles into substances not only deleterious to itself, but to other plants, and that a portion of this poison is also rejected by the roots, so that a vegetable may suffer from the absorption of the very poisons it furnishes. Hence it has been inferred that the continual elongation of the roots renders the effect hurtful, not to the same generation of plants, but to the next and succeeding crops of the same species; and that, on the contrary, it is possible that the excrementitious matter which they throw off would furnish wholesome and abundant nourishment to another order of vegetables.

The conclusions arrived at by M. Macaire, after making a large number of experiments on different families of plants, as well as on individuals, were as follows: First, that most plants exude by their roots substances useless to vegetation; second, that the nature of

these substances varies according to the families which produce them; third, that some being pungent and resinous may injure, and others being sweet and gummy may contribute to the nourishment of other vegetables; and, fourth, that these facts tend to confirm the theory of the rotation of crops suggested by De Candolle.

The facts elicited from these experiments present themselves with a force of analogy, in the case of the blight in the cotton plant, no less striking than remarkable; and the subject appears to be well worthy the careful thought and investigation of a competent chemist and an intelligent agriculturist. A remedy for this disease here presents itself, in adopting a three or four-course rotation, by alternating cotton with peas, Chinese sugar-cane, chufas, perhaps, Indian corn, or some other renumerative crop which can readily be converted into the flesh of cattle, sheep, horses, or swine. There is nothing repugnant in this theory to probability and common sense; but, like all things connected with science, in order to become available in practice, it must be based upon sound, unerring truth, sustained by facts which cannot be controverted, and deductions that admit of no doubt; these alone bring conviction and lead to conclusions upon which the mind may confidently repose.

D. J. B.

PERSIAN INSECT POWDER.

For a long period, a preparation was used throughout the Russian Caucasus for the destruction of injurious insects, and was regarded as a secret to the rest of the world, until its properties became known to Mr. Jumtikoff, an Armenian merchant, while travelling through that country some forty or fifty years ago. He communicated his discovery to his son, who manufactured the article, in 1828. This powder, or the plant from which it was obtained, was soon after introduced into Alexandropol, and subsequently into Germany, where its popularity is rapidly increasing.

There are several plants similar in character, called by botanists *Pyrethrum carneum*, *Pyrethrum roseum*, and *Pyrethrum purpureum*, (Persian cammomile, flea-grass, or flea-killer,) from which this powder is procured, consisting of small perennial shrubs, from 12 to 15 inches in height, bearing flowers an inch and a half in diameter, and resembling those of the ox-eye daisy, (*Chrysanthemum leucanthemum*,) except in color. They grow on the mountains of the Caucasus, at an elevation of 5,650 feet above the level of the sea, in a temperature of 68° F. They are of easy cultivation in gardens, and since their hardiness have become known, they have been introduced into Germany, Holland, and France, for the purposes of ornament, where they begin to flower in June. They will flourish in any ordinary garden soil, and may be propagated by layers as well as by seeds.

The parts of the plants from which the powder is made are the dried flower-heads, gathered. when ripe, on fine days, and usually

dried by exposure to the sun; but they have been found to be more serviceable when dried in the shade, during which operation they are occasionally turned. In the process of desiccation they lose about 90 per cent. When perfectly dried, they are first comminuted with the hand, and then reduced to powder in a small mill.

A quantity of these plants grown upon 18 square rods is estimated to furnish 100 pounds of powder, which is best preserved in sealed vessels of glass. The application is made either as a powder or as an infusion, though in the latter form, it is more beneficial, especially when intended for the destruction of insects on plants. The dried leaves only should be used for an infusion, as the green ones are ineffectual. The powder may be applied directly to the insects themselves, or in the places which they frequent. They are attracted by its smell, become stupified, and immediately die. This substance may be employed without injury to the larger animals or man. It is estimated that the amount of this powder consumed, per annum, in Russia alone, is nearly 1,000,000 pounds.

At present, there are more than twenty villages in the district of Alexandropol engaged in cultivating the plant and collecting its flowers and leaves.

D. J. B.

HISTORY.

EARLY AGRICULTURAL HISTORY OF ILLINOIS.

BY JOHN REYNOLDS, OF BELLEVILLE.

[Condensed from the Transactions of the Illinois State Agricultural Society for 1856–'57.]

Religious altars, Kaskaskia, and agriculture commenced together in the American "bottom" in the same year (1682) that Philadelphia was laid out, one hundred years before any permanent settlements were made in either Kentucky or Tennessee, and twenty-eight years before the foundation of New Orleans. The villages of Cahokia and Peoria commenced their existence about the same time and manner with Kaskaskia, and those then French villages formed the nucleus of the first colonies established west of the Alleghany Mountains. Fort Crèvecœur was erected by La Salle on the northern bank of Peoria Lake, a mile and a half above the present city of Peoria, some few years before the colonies were settled, and the Rock Fort, or Fort St. Louis, was established soon after on the "Starved Rock," which is situated on the south side of the high rocky bluff of the Illinois river, about six miles southeast from the city of La Salle. These forts were garrisoned for some years by French soldiers, to secure the Indian trade, and to keep possession of the country.

Father Allowes, a Jesuit, located in the Indian village on the exact site where Old Kaskaskia now stands, and commenced to Christianize the natives. The Rev. Mr. Pinet, another Jesuit priest, commenced his Christian labors in the Cahokia village of Indians, which occupied the same place that the present town of Cahokia does. The traders also assembled in these Indian towns, and thus, by Christianity and benevolence, they were changed into civilized and happy colonies of whites.

Agriculture made its first entrance into Illinois around these villages in the year 1682. The French pilgrims from Canada immigrated to the country with the pure and holy principles of Christianity, and lived in peace and friendship with the numerous tribes of savages, which were legion at that time in the West. They had scarcely any wars with the natives, but resided with their neighbors, white and red, for a hundred and fifty years, in perfect harmony. These French colonists never disturbed any one on account of their religion, nor persecuted Quakers nor any other sect for difference of opinion. But these immigrants were not good farmers. About one-half of the population depended on the Indian trade and voyaging for a living, and the other half were husbandmen, and cultivated the fields. These colonies were established where the soil was exceedingly fertile and easily cultivated. A very small amount of labor raised much produce. Large common fields were inclosed with few rails in the fence, the rivers, bluffs, or lakes generally answering for some part of the inclosure. Wheat, mostly of the spring variety, and a hard, flinty kind of Indian corn were cultivated and raised in sufficient quantities to support the inhabitants, and much for exportation South. The villages of Prairie du Rocher, Fort Chartres, St. Philips, and Prairie du Pont were added to the former colonies, and a great portion of the whole bottom was in cultivation at the highest points of French prosperity, in Illinois. I have seen the marks of the plough for 20 or 30 continuous miles above Kaskaskia, in the bottom, where the land would admit, and in an extensive range of country around the villages of Cahokia and Prairie du Pont. It is stated by authors that great quantities of flour were shipped to New Orleans, in olden times, from the Illinois and Wabash colonies.

The agricultural implements of the French were defective, and not of the character that would be tolerated at this day. The poverty of the country and the want of skill forced the people to use carts without iron. In alluvial soils, where rocks or gravel did not appear, these carts performed tolerably good service—much better than sleds. The ploughs were honored with only a small point of iron on the front in the ground, and that tied to the wood with raw hide straps. The beams rested on axles, supported by small wheels, also without iron, and the whole concern drawn by oxen—horses not being used in the ploughs by the French in pioneer times—and the oxen were yoked to the ploughs by the horns. Straps of untanned leather tied a straight yoke to the horns of the oxen, and a pole, or tongue, coupled the yoke to the wheeled carriage, on which rested the beam of the plough. At this early day, the French farmers used no small

ploughs, and had none. In the war of 1812, they obtained the knowledge from the Americans of the use of the small ploughs to work amongst the green corn. Before the war, the French and Americans were strangers, and learned nothing from each other. I presume for more than one hundred years, the French ploughed in their corn about the 1st of June, and turned under the weeds, and not many grew until the corn was up out of their reach. They planted the seed corn in the furrows as they broke the ground, and turned the furrow-slice on the corn planted, opened a few furrows more and planted another row of corn, and so on, until the field was completed. The weeds were kept down with the hoe, or brier scythe. Sometimes strange looking Indian pumpkins were planted with the corn, and at times, though seldom, turnips were sown between the rows. Potatoes were not raised to much advantage—not sufficient for the consumption of the people—I mean the French inhabitants of olden times. The Americans have always raised an abundance of these roots, since my recollection, in Illinois. For many years, there were no sweet potatoes cultivated in the country. Not much corn was raised by the French in pioneer times, as they did not use it to any great extent for bread, and their stock wintered out, for the most part, in the range. In summer, the pasturage was excellent, and all kinds of stock were generally fat. Corn was sold to the Indian traders on which to support the *voyageurs* and *couriers du bois*, and some used to fatten their hogs.

The history of one year of French agriculture will serve for nearly one hundred and fifty years; as I believe, in that long period, not a new principle was ingrafted into the system, nor an old one abandoned. A mathematical similarity reigned in all the French colonies, until the Americans introduced new agricultural principles among their French neighbors.

The wheat crop was generally sown in the early spring, and tolerably well ploughed in with the ox-team. It was cut with sickles, or reap hooks, as no cradles existed in those times. They bound the sheaves with grass cut for the purpose, hauled the crop home either in horse or ox-carts, and stored it away in barns. The ancient custom at "harvest home" was, to tie together some nice straws of the wheat in the shape of a cross, and to place it over the gate of the husbandman. This exhibition was in praise to Providence for the harvest, and also to show that the crop was housed in the barns. In winter, the wheat was threshed out in the barns with flails, and ground, for the most part, in horse-mills. The spring wheat made good, dark-colored bread, which many preferred to that made of fall wheat.

Little or no oats, rye, barley, nor buckwheat were raised in Illinois for one hundred and fifty years from its first settlement. The French never cultivated, to any great amount, either flax, cotton, or hemp. nor did they manufacture into clothing what little, if any, they did raise. They used very few spinning wheels, and I do not recollect ever seeing a loom among them. All their clothing, except the deer skin moccasins they wore, they purchased at the stores. They raised

considerable stock—horses and cattle, some hogs, but no sheep nor goats. Their horses, known as "French ponies," were numerous, and of excellent pedigree. They were generally small, but of the pure Arabian stock, from Spain. No care was taken of them for more than one hundred and fifty years, and the breed scarcely ever crossed. Many generations of them never ate an ear of corn or other grain, but lived on the range, winter and summer. The French kept no stable horses; but let all the males run in their natural state. These ponies endured much more hardship than the American horses, and would do more service, living on the range, without grain.

French cattle were immigrants from Canada, and were a small, hardy breed, generally with black horns. They stood the winter better, without grain, than the American cattle, and gave less milk in the summer.

The French never raised hogs in proportion to their other stock. They lived on vegetable diet more than the Americans, and used less pork. Bacon was uncommon among them. They rendered a fat hog into lard for the family, and pan-cakes then were triumphant.

The common fowls were abundantly raised amongst the early French, and the poultry and eggs gave the people healthy and agreeable support. They excelled the American masses in raising fowls, and were attentive to the cultivation of their gardens, which gave them a good part of a cheap living.

The French, English and American governments awarded to the French colonies large commons, attached to the villages, to advance agriculture; but at this day, these commons are appropriated to raise a fund to support the public schools.

D. J. B.

SALT.

THE HISTORY, COMMERCE, SOURCES, MANUFACTURE, AND ECONOMICAL VALUE OF SALT CONSUMED IN AND EXPORTED FROM THE UNITED STATES.

BY WILLIAM C. DENNIS, OF KEY WEST, FLORIDA.

It has been assumed that great power and influence have accrued to certain nations because of their possessing the sources of salt and the skill and enterprise to supply it in commerce; and coincidences leading to this conclusion are certainly not unfrequent in the history of the world, whether they may be viewed in the relation of cause and effect or not. It has thus been alleged that the commercial power of the Roman empire was built upon the Etrurian salt-works of Ostia; that the influence of Venice in the middle ages arose from a like cause; and that France and England have successively increased

in commercial importance in the ratio of the development of their salt-producing capabilities. It certainly cannot be questioned that, in the nature of things, this source of wealth must confer great blessings on its possessors, enabling them to supply the world with an essential of life, and to rejoice in their own independence in a matter of primary utility.

The experience of the United States has been adapted to inculcate this lesson, its early privations in this particular having been very great. The history of our salt manufactures, indeed, would be interesting and profitable, could the requisite data be obtained; but many feeble and imperfect attempts were made before the achievement of a successful issue. Perhaps the first of these was that alluded to in Beverly's History of Virginia, wherein it is stated that, in 1620, "a salt-work was set up at Cape Charles, on the Eastern Shore;" with what success, however, is not mentioned. Another attempt was made four years later, at Plymouth, in Massachusetts, of which the following record is obtained from Prince's Chronological History of New England.

"1624. At Cape Ann there is a plantation beginning by the Dorchester men by which they hold of those of New Plymouth; who also by them have set up a fishing work. * * * * * In the same ship which brought Mr. Lyford to Plymouth, came a carpenter and a salt-maker, both sent by the adventurers. The carpenter, says Governor Bradford, 'is an honest and very industrious man, quickly builds two very good and strong shallops, with a great and strong lighter, and had hewn timber for two ketches, but this spoilt; for in the heat of the season of the year he falls into a fever and dies to our great loss and sorrow.' The salt man he describes as ignorant, foolish, and self-willed :—'chuses a spot for his salt-works, will have eight or ten men to help him, is confident the ground is good, makes a carpenter rear a great frame of a house for the salt and other like uses, but finds himself deceived in the bottom; will then have a lighter to carry clay, &c., yet all in vain. He could do nothing but boil the salt in pans. He next year is sent to Cape Ann, and there the pans are set up by the fishing; but before the summer is out, he burns the house and spoils the pans, and there is an end of this chargeable business.'"

In the same work the following minute also is quoted :

"1629, March 10.—At a meeting of the Massachusetts Company, in London, Mr. Thomas Graves, of Gravesend, gentleman, agrees to go to New England, and serve the company as a person skilful in mines of iron, lead, copper, mineral salt and alum, fortifications of all sorts, surveying, &c."

At the birth of this Republic, and during the only defensive war it has since been called upon to wage, we felt most acutely the inability to supply our want in this substance. In both these periods, temporary salt-works were erected under the special favor of several States of the Union, and a maximum price for salt was in some instances established by law.

During the Revolutionary war, salt was manufactured along the

sea-board of the United States by boiling sea-water, and after its close, quite an extensive system of salt-making grew up around New Bedford and Cape Cod, at which works, after the plan was perfected, a large quantity of as pure an article as any ever made was obtained, but from the fineness of the grains it was not well fitted for salting pork, in barrels. The plan adopted was the origin of the one practised at present in the State of New York for making solar salt. Each of the lines of the narrow shallow vats, with their movable roofs, were more than 1,000 feet long, one end of which was higher in level than the other, with a regular gradation the whole length. Sea-water was pumped into the highest end, and as it strengthened by the evaporation of the sun and air, it was let from one level to another till it arrived at a certain point in the line, beyond which it was not permitted to go, until reduced to the point of saturation with common salt, when the brine deposited all its impurities, except those more soluble than that salt, such as the muriate of lime and the muriate and sulphate of magnesia, the solution of which always drains off entirely from perfectly formed crystals of common salt. The remainder of the line of vats from this point was used alone for crystallizing the salt, no brine being allowed to come into this part of the line before it was evaporated fully up to saturation. The salt taken from these pans was remarkably heavy and strong. For salting beef and fish, and for preparing bacon and hams for the smoke-house, no salt could be better; but after our last war with England, when foreign salt could be bought for less than 50 cents per bushel, these works were suffered to go to decay, and now few of them are in operation.

Some eighty years ago, there were many small establishments in Massachusetts for boiling salt from sea-water. That of Messrs. Obed E. Smith and Job Chase, at Harwich, consisted of twelve kettles, of 16 gallons each, set in mason work, and protected from the weather by a low building. At first, they raised the water by a hand-pump, afterwards by a wind-mill, and conveyed it in gutters to the boilers. This establishment was continued till after the close of the Revolution, a period of more than twenty years. In Falmouth and Barnstable, there were similar establishments. In fact, the restrictions imposed on our commerce by the British Parliament for several years prior to the Revolution, by cutting off the supply of foreign salt, compelled almost every man on the sea-board to become a manufacturer. The exorbitant price of foreign salt, and the distress occasioned at this period, obliged many to continue this petty business, and induced others to adopt other means for making salt for their own consumption. Soon after the close of that war, boiling salt was discontinued, and has not since been resumed in this State.

The salt made by this process was a very inferior article. It was fine-grained, and imperfectly separated from the lime, salts of the bittern, and other impurities contained in the water. In order to obtain a single bushel of salt, 8 barrels, or 252 gallons of sea-water had to be evaporated, for the most part, in kettles unsuited for

that purpose, hanging over a fire, or set in mason work unprotected from the weather.

But an apparently unimportant observation, one of those small incidents which often pave the way to great discoveries, established the fact that salt could be made in this climate by solar evaporation. Several salt-boilers, at Harwich, remarked that some clam shells on the sea-shore contained minute crystals of salt. These, they concluded, must have been formed by the drying away of the water left in them by the tide. The correctness of this opinion they soon ascertained by filling several and placing them on posts. Mr. Ammiel Weeks, of that town, made another experiment, which was more satisfactory. He constructed a shallow box, open at the top, 6 feet in length by 2 feet in width, and divided into three compartments by narrow strips of board placed crosswise on the inside. This he filled with sea-water, and exposed it to the sun's rays, in fair weather, and at other times kept it covered. With this simple apparatus, he manufactured salt sufficient for his own consumption. This experiment was made in the year 1774, or 1775, and was probably the first salt made in the United States by solar evaporation, although it was practised in France and other countries many years before. About the same time that Mr. Weeks made his experiment, an unsuccessful attempt to manufacture salt was made at the Isle of Shoals, in New Hampshire. A vat, about 10 feet square and a foot in depth, was scooped in the ground, and made tight with a layer of clay. Over this, a rude frame was erected to support the boards which formed a covering on the approach of a storm. The next attempt to manufacture salt in works constructed on the plan now generally adopted in this country, was made in 1776, or 1777, by John Sears, of Dennis, who had previously led a sea-faring life. Possessing an inventive genius, he conceived a plan for manufacturing salt by a less tedious and more economical process than the boiling down of sea-water. Wanting the means to test the practicability of the plan, he associated himself with Edward Sears and Christopher and Edward Crowell. The latter had seen the works at the Isle of Shoals, but it does not appear that John Sears had any knowledge that salt had ever been made in works similar to the ones he proposed to build. The situation which they selected was on Quivet Neck, in the northerly part of Dennis, (then Yarmouth,) at a small distance from the sea-shore. The vat, or "bottom," as it is generally called, was constructed 100 feet in length and 10 feet in width, and all on the same level. The flooring was white pine plank, laid on oaken sleepers, the latter running crosswise, and the former lengthwise. The gunnels, or sides and ends, were also of plank, 8 inches high, and secured to the flooring by by upright pieces mortised into the ends of the sleepers, supported by knees passing under the flooring and on the outer sides of the gunnel pieces. The corners of the vat were also secured by knees. The roof was curiously fashioned. Rafters, grooved on each side, were permanently fastened to the gunnels, at the distance of from 5 to 6 feet from each other. The doors were made of a corresponding width, and consisted of several boards of the same length of the rafters,

clamped together like a common door. These were moved obliquely upwards and downwards in the grooves of the rafters, when occasion required, and they were prevented from sagging in the centre by slender rafters placed between the principal ones. It was soon found necessary to have a separate vat for crystallizing the salt. A partition was accordingly placed across the original vat, dividing it into two. For the first two years, water for the supply of these works was brought in buckets from the sea-shore; but just before the close of the Revolution, Mr. Sears procured one of the pumps of the British ship-of-war Somerset, which was stranded on the coast of Cape Cod, and erected it for the supply of his manufactory with water, and to avoid the labor of boiling. About 1790, he constructed, for the purpose, a wind-mill, on the plan of those then in common use. Like other inventors, Mr. Sears did not escape the shafts of ridicule. For a long time, his manufactory was known by the appellation of "John Sears' Folly," and to avoid the sneers of the less enterprising, he constructed his mill in secret.

In Brewster, (then Harwich,) in this State, Mr. Scott Clark and Rev. Mr. Dunster commenced the manufacture of salt a little before the close of the Revolution. Their works were built on Broad Point, in the north part of that town, and were constructed like Sears', except they were divided into three vats. They had no pump for several years, but afterwards one was constructed like a common hand pump. Mr. Nathaniel Freeman, of Brewster, also built salt works about the same time.

In Barnstable, the first salt-works were built by Mr. Admo Hinckley and Nathaniel Gorham, in the year 1779. They were constructed on Mr. Sears' plan, about 50 feet in length and 10 feet wide, and divided into two vats.

In other parts of Massachusetts, there were works similar to the latter for the manufacture of salt by solar evaporation; but many of these were broken up soon after the close of the Revolution. A few vats, however, exist at Cape Cod, in which salt is still manufactured to a limited extent.

In 1830, there were manufactured in this State about 600,000 bushels of salt by solar evaporation, after the method above described, since which it has generally been discontinued.

As sources of supply of common salt in the United States, New York, and what may be called the Salt Basin of the Kanawha, are of much greater magnitude than any and all others. Before the Revolution, the discovery of salt springs is spoken of in these regions, since which time others have been found on the surface, or by boring in different localities. At present, the principal salt-works in this basin are found in New York, Virginia, Pennsylvania, and Ohio, with some minor works in the adjacent States. Nearly all of the brine wells there contain petroleum, and many of them to such an extent as to be of commercial value. Most of the salt is manufactured by the boiling process, except a part of that of New York.

The springs which underlie a large portion of Western New York issue naturally from the earth, and attracted the attention of the

Indians long before the settlement of this region by Europeans, as crystals of salt appeared on the surface of the black mud in their vicinity. Father Jerome Lallemont is believed to have been the first white man who mentioned these "salt fountains." Le Moyne, a Jesuit, also noticed them in his journal, published in 1653. More recently, in 1770, Onondaga salt was in common use among the Delawares, and the traders brought quantities of it to Albany with their furs, as a matter of curiosity. At the same time, the Indian women sent this salt to Quebec for sale. The first white settlers commenced making salt, by boiling, in 1788, near where Syracuse now stands.

In 1797, the first laws were enacted in New York for the regulation of salt-works; and in no case has there been granted to individuals in fee simple any saline belonging to this State, which opens the wells and keeps them in repair. It is at the expense of building the tanks, or reservoirs, into which the brine is pumped for the purpose of freeing it from impurities as much as possible, previous to its being distributed to the several lessees, who complete the manufacture of the salt. These reservoirs are in the exclusive charge of the State, which also furnishes the aqueducts for distributing the brine to the lessees, who pay a cent a bushel of 56 pounds, in the way of rent, or duties, on all salt manufactured. The strength of the brine is measured by an instrument called a "salometer," arranged by designating distilled water 0, and the same kind of water saturated with common salt 100. With instruments thus graduated, the brine of the Onondaga salt-works varies at different places and seasons from 76° down even as low as 44°. The wells which do not furnish brine above 50° are not considered worth working.

There are made by solar evaporation, at the Onondaga works, from 500,000 to 600,000 bushels of salt per annum, which has the specific gravity of all solar manufactured salt, and unquestionably possesses superior antiseptic qualities. It is made in long, narrow, shallow wooden vats, elevated a few feet, with movable roofs, which are run on and off, as the weather may require, similar to those formerly in use in Massachusetts. When the works are in operation, they generally require 3,000,000 gallons a day, and the average daily supply for six months is not less than 2,000,000 gallons. The average cost of manufacturing salt by boiling during five consecutive years was about $1 per barrel of 280 pounds, the minimum price being in 1849, 1850, and 1851, from 70 to 90 cents; in 1852, $1; in 1853, $1 12; in 1854, $1 25; in 1855, $1 30, in 1856, $1 40 per barrel. The solar-made salt costs about the same as that boiled. It weighs about 75 pounds to the bushel, while the boiled salt weighs only 56 pounds, the latter varying, however, according to the position of the kettles, to a weight considerably above, as well as below, this standard, which is the number of pounds reckoned to the legal bushel of the State.

A salt block for boiling, at Onondaga, of the largest size, is constructed of bricks, from 12 to 15 feet wide, 4 to 5 feet high, forming two parallel arches, extending its whole length. Within the top of these arches, are placed common cast-iron kettles, containing from 50

to 70 gallons, set near together in two rows, the entire length of the arches. A fire built in the mouth of these arches passes under each kettle into a chimney, which may vary in height from 50 to 150 feet. The number of kettles to these double blocks varies from fifty to seventy, and the amount of salt made in one of them, say in eight months of the year, varies from 20,000 to 25,000 bushels of 56 pounds.

The following is a statement of the number of bushels of salt made at the Onondaga Salt Springs since June 20, 1797, which is the date of the first leases of lots :

Years.	No. of bushels.
1797	25,474
1798	57,928
1799	42,474
1800	50,000
1801	62,000
1802	75,893
1803	90,000
1804	100,000
1805	154,071
1806	122,557
1807	165,448
1808	319,618
1809	128,282
1810	450,000
1811	200,000
1812	221,011
1813	226,000
1814	295,215
1815	322,058
1816	348,234
1817	448,665
1818	406,540
1819	526,049
1820	548,374
1821	558,329
1822	481,562
1823	726,988
1824	816,634
1825	757,203
1826	811,023
1827	983,410
1828	1,160,888
1829	1,291,280
1830	1,435,446
1831	1,514,037
1832	1,652,985
1833	1,838,646
1834	1,943,252

Years.	No. of bushels.
1835	2,209,867
1836	1,912,858
1837	2,161,287
1838	2,575,033
1839	2,864,718
1840	2,622,305
1841	3,340,769
1842	2,291,903
1843	3,127,500
1844	4,003,554
1845	3,762,358
1846	3,833,581
1847	3,951,351
1848	4,737,126
1849	5,083,369
1850	4,268,919
1851	4,614,117
1852	4,922,533
1853	5,404,524
1854	5,803,347
1855	6,082,885
1856	5,966,810
1857	4,300,000

Salt springs are found in almost every part of Kentucky. From these springs, or licks, with proper management, salt may be made in sufficient quantities for the consumption of all the inhabitants the Western country could support. Notwithstanding the high price of labor, and the imperfect manner in which the business of making salt was carried on, yet the average price of that necessary article, at those licks, for several years previous to 1795, was from $1 to $2 per bushel. The most noted of those springs, or licks, are—one on Salt Lick Creek, near the Ohio; the upper and lower Blue Springs, on Licking River; Drennon's Lick, on Kentucky River; Big Bone Lick, Long Lick, Bullett's Lick, and Mann's Lick. The method of procuring water from these licks is by sinking wells from 20 to 40 feet deep. The water drawn from these wells is represented to be as strongly impregnated with salt as sea-water.

The salt-works in Southern Illinois, although they are not worked at the present day, were once in successful operation, and supplied the country with this indispensable article, from its earliest settlements by the Europeans. The celebrated salt springs situated a few miles south of Equality, in Gallatin county, were known and worked by the Indians and French of Vincennes from the time the colonists commenced at that village, in about the year 1720, and still pour out volumes of water. But from the scarcity of fuel in that vicinity, the manufacture was abandoned.

The "United States or Ohio Saline," at this day, stands in reserve as a check to regulate and keep down the price of imported salt. It

was in successful operation under Colonel Isaac White, in about the year 1812. Other salt-works were situated on Big Muddy River, not far below Murphysborough, in Jackson county, and on the east fork of Silver Creek, in Madison county, as well as on the upper branches of Little Muddy Creek. All of these works produced considerable quantities of salt, but much less than those at the Ohio Saline, like which, and most others in the State, they have fallen into disuse.

Although salt springs abound in the States of Pennsylvania, Virginia, Missouri, and Tennessee, from which considerable quantities of salt were manufactured by the early settlers for domestic purposes, very little at present is made in these States. Mines of rock salt also exist in Missouri, Utah, California, and in other parts of the Far West, which promise at some future day to become of vast account. But perhaps the most reliable source for obtaining salt in the United States is from the evaporation of sea-water by solar heat, all along the coast, from New Jersey to the Rio Grande. South of Cape Florida, salt can be economically manufactured wholly by this process, if the French method of concentrating it on a part of the works as hereinafter described, be adopted, and, if convenient points be selected both for making and shipping the article. North of that point, it can be made cheaply by the aid of "graduation," (technically so called,) and other analogous methods of increasing evaporation, if concentrating it on a part of the works, as above, be not found sufficiently powerful in practice.

The southern coast of Texas and the Florida Keys are peculiarly fitted for making solar salt without extensive artificial aids to evaporation, but most of the States and Territories in the Union have supplies of brine, and the climate is sufficiently hot and dry to bring them to saturation without fire, if care be taken to crystallize slowly and in such a manner as the science of chemistry unfolds.

Solar made salt can also be produced cheaply on the coast of California from San Francisco to San Diego. In fact, from the seasons being divided into dry and wet, that region is peculiarly fitted for salt-making by solar heat.

The Great Salt Lake of Utah seems the strongest and purest brine fountain known. Its water is generally at 22° Beaumé. Captain Stansbury records that he saw millions of bushels of salt crystallized on its western borders, and that he made use of the unstrengthened water of the lake successfully to cure beef.

A singular salt lake, or pond, is found some 55 miles northward from Brownsville, in Texas, comprising 30 to 40 acres in extent. The salt is crystallized over the bottom of this pond to an unknown depth, with brine over it to the depth of one or two feet. Salt is cut out for use, but soon crystallizes again to the same level.

The following table will exhibit the relative strength of the different brines from which salt is manufactured in the United States :

At Nantucket,	350 gallons	sea-water* give a bushel of salt.	
Boon's Lick, Missouri,	450	do	do
Conemaugh, Pennsylvania,	300	do	do
Shawneetown, Illinois,	280	do	do
Jackson, Ohio,	213	do	do
Lockhart's, Mississippi,	180	do	do
Shawneetown, (second saline,)	123	do	do
St. Catharine's, Upper Canada,	120	do	do
Zanesville, Ohio,	95	do	do
Kenhawa, Virginia,	75	do	do
Grand River, Arkansas,	80	do	do
Illinois River, Arkansas	80	do	do
Montezuma, N. Y., (old wells,)	70	do	do
Grand Rapids, Michigan,	50 to 60	do	do
Muskingum, Ohio,	50	do	do
Montezuma, N. Y., (new wells)	50	do	do
Onondaga, N. Y., (old wells,)	40 to 45	do	do
Onondaga, N. Y., (new wells at Syracuse)	30 to 35	do	do

Let us now briefly examine some of the principal processes for making salt by solar evaporation on a large scale; and as the French methods are believed to produce the best articles, and those pursued in that country without the aid of graduation being well adapted to the extreme southern part of the United States, we will begin with them. Besides many salt-works at brine springs in the interior, salt is extensively manufactured along the Mediterranean, and on the Atlantic side, principally around the mouth of the Loire, and the low coast in its vicinity. In the last-named region, where the tides rise high, extensive reservoirs are kept at high water by means of swing gates, which open at the flood and close at the ebb, being placed in a dam across some arm of the sea. Each of these reservoirs frequently supplies numerous salt-works. Salt-making is a government monopoly; the works are national property, and are divided into lots of from 30 to 500 acres, to suit the convenience of the persons who rent them. These works are so situated as to be commanded by the level of a principal reservoir, whether they be large or small, the sea-water flowing slowly from it into a series of lesser reservoirs and long winding conduits, till it comes to the crystallizing pans, between which, there are also long, narrow passages, each of the works being arranged with these smaller reservoirs and pans, wherein the salt crystallizes in such a manner that the incoming water flows over the strengthened brine from reservoir to reservoir, through the passages named, till it has evaporated to the point of saturation, when it is permitted to crystallize in a pan prepared for the purpose. It is then

*Of the sea-water at New York, about three hundred gallons would give a bushel of salt. The following are the results of an examination of a portion of water taken from the East River, at very high tide: Specific gravity at 60° F., 1.02038. 1,000 grains contained 26.8 grs. of dry saline matter, namely: Carbonate of lime, 1.22; carbonate of magnesia, 0.5; sulphate of lime, 0.8; sulphate of magnesia, 1.72; chloride of magnesium, 2.26; chloride of sodium, 20.3.

raked out and placed in piles to drain, whence it is removed to store-houses for use. As above stated, the crystallizing pans are to be arranged so that the brine can be made to flow from one to another through the passages, that a part of the series can be used for strengthening the brine when the weather is unfavorable; besides, the rapidity of the crystallization is greatly increased when the saturated brine is in motion. The distance that the brine flows from the main reservoir to the last pan is frequently more than 10 miles in the largest works, and seldom less than 3 in the smallest. This plan not only purifies the brine, and produces a salt free from the defects of other kinds of solar-made salt, but hastens the process of making to such an extent as to render it of the first importance in so variable a climate as ours. This plan enables the salt-maker to concentrate the evaporation of his whole works on as many of the lowest pans in the series as he may find the most advantageous, or the state of the weather requires, in order that at least a part of the accumulation may be made, even in the most unfavorable seasons.

At many of the French salt-works, other plans are adopted to hasten the evaporation, such as pumping the weak brine into tanks 20 to 30 feet high, and then letting it down in showers through fagots placed in frames of that height, and which are frequently 50 by 100 feet, or upwards, on the ground. Weak brine is also thrown into the air with machines similar to fire engines, and falls in showers on high piles of brush. Many of these plans for increasing evaporation are in use on the Mediterranean, where, the range of tides being limited, the water necessarily has to be pumped up into main reservoirs, sufficiently high to command the level of the general works.

In many parts of France, salt is made by collecting the mud during the dry, hot season, from places where the sea occasionally flows over it, and placing it on thick layers of straw in an elevated position, after which the water is pumped on it, and leaches through the mud and straw, finally descending through a system of fagots, to increase the evaporation. This brine is much stronger than sea-water when it first leaves the mud and straw, according to the degree in which the mud has been impregnated.

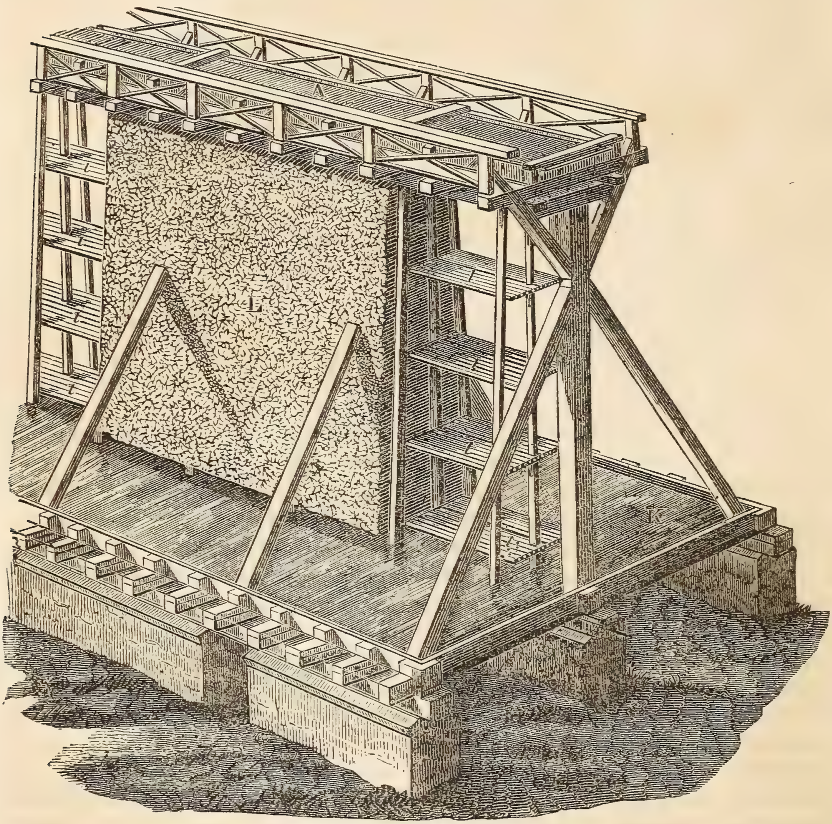
Salt is also extensively manufactured in the interior of France from brine springs, the strongest of which are in the vicinity of La Meurthe. These contain, on an average, 35 per cent. of salt. The system of graduation is pursued at many of these works.

In the southern part of Germany, and, in fact, throughout the greater part of that country, much good salt is made from sea-water, from brine springs, and from the solution of impure rock salt, these brines being brought to the point of saturation with common salt in some works after the French plan, aided by a system of fagots called "graduation," and by throwing weak brine into the air and letting it fall in showers on high piles of brush, and other analogous methods to increase evaporation. The greater number of these springs, however, are far too dilute, with the existing prices of salt, to repay the cost of evaporation by means of fuel. At Salzhausen, for instance, the production of 100 pounds of salt presupposes the evaporation of

about 339 cubic feet of brine. At Schönebeck, the annual produce of upwards of 57,500,000 pounds of salt is obtained by the evaporation of 19,000,000 cubic feet of water. In all the brine springs, therefore, which are far removed from a state of saturation, the greater portion of the water is reduced in bulk by evaporation in the air, (graduation,) the smaller portion by boiling.

The graduation house is intended to distribute the brine in the form of rain, and expose it to the air in this state, whilst the action of the latter is increased by stopping and retarding the single drops as they fall.

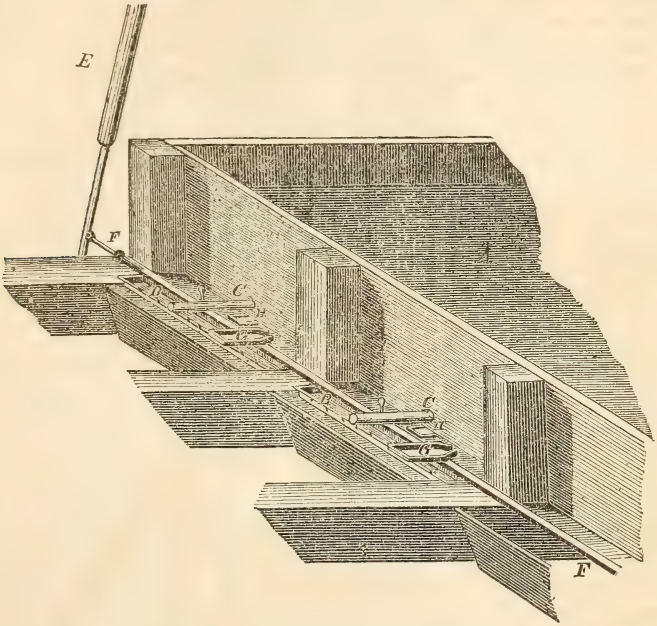
The brine is caused to fall from the trough or cistern *A*, as indicated by the following cut, into the tank *K;* the retardation is



Apparatus for Evaporating by Graduation.

effected by means of a wall of twigs, or fagots, *L*, and its distribution in the form of rain by means of a series of perforated tubes and plugs, as shown in the following diagram. The motive power raises the brine into a large reservoir, generally placed in a tower, whence it must be enabled to flow freely into the trough *A* as it is wanted. By means of the horizontal pipes *C C*, the brine is conducted in a thin stream to the dropping channel *B B*, which extends throughout the whole length of the graduation, and from thence it falls, drop by drop upon the wall

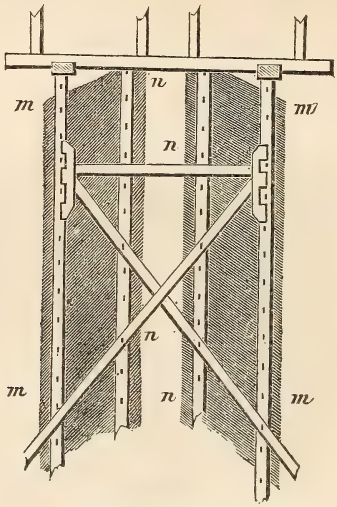
of twigs *L*. This structure is composed of fagots of black-thorn, placed between the lath-work *l l*, in a horizontal even manner. The protecting board *I I*, prevents the wind, which must pass through the thorns, from giving a wrong direction to the drops which are constantly falling on the outer side. That the air may exert its full influence,



Graduating Trough, or Cistern enlarged.

the whole structure for graduation is erected in an airy place, and in a direction at right angles to that of the prevailing wind. It is obvious that this arrangement must expose the extended surface of the brine for a longer time to a constant current of air. If the wind changes, and threatens to carry the brine away from the wall and over the structure, the graduation must be reversed to the opposite surface of the wall of fagots; and this is done by a simple movement of the lever *E*, for which purpose it is attached to the wooden rod *F F*, supporting the boxes *G G*. The lever brings the wooden rod forward, and with it the boxes *G G* are moved into a position just under the horizontal pipes, so that their narrow lips at the back project over the cross channels *H H*. Thus the brine is intercepted above the channels *B* and carried to the other side and opposite surface of the fagots, by a channel precisely similar to *B*. That the whole arrangement of spigots, channels, &c., may be easily managed, planks for walking are laid on both sides of *A*, and these are furnished with a railing. The erection for graduation here described, as it is practised in Salzhausen, is known as the "one-walled" graduation house, and is used in small works where building materials are scarce. The walls of thorns, however, are frequently made in pairs, as indicated in the annexed cut, and sometimes the outer surfaces *m m*, only

are used (surface graduation;) at others, the inner surfaces *n n*, are employed at the same time (cubic graduation.) The latter practice does not quite double the effect, but (from observations made at Dürrenberg), it increases it in the ratio of nearly 5 to 9. In



Walls of Thorns.

each of these operations, the brine must be allowed to fall three, four, six, or even eight times through the fagots. For this reason, the graduation houses are partitioned into several compartments, the foremost of which serves for the first, the second for the next fall, and so on. At Schönebeck, the effective surface of the fagot wall comprises 390,000 square feet, and evaporates, on an average, during the day, 3.7 cubic feet of water from each square foot; therefore, in the year, (258 working days,) the whole evaporates above 44,000,000 hogsheads, of 63 gallons each.

According to an antiquated method, the graduation was effected by distributing the brine over flat, inclined wooden surfaces, or over ropes stretched backwards and forwards for a length of many thousand feet.* The thorn walls, introduced into Saxony from Lombardy, in the year 1559, have superseded, in Germany, every other plan. It is easily understood that graduation proceeds best with a moderately warm wind and sunshine, that a moist calm atmosphere is less favorable to it, and that in rainy weather, it is altogether stopped, whilst the wind, when it acquires a certain force, is liable to carry the brine entirely away from the cistern. Frost, also, is prejudicial; for Berzelius observed that, below 27° F., sulphate of magnesia, with a portion of chloride of sodium, became converted into chloride of magnesium and Glauber's salt, and that this decomposition is not reversed when the weather becomes warmer. Salt, therefore, is not only lost in this manner, but the quantity of chloride of magnesium is increased,

* Thus, for instance, at Moutier, in France, where salt is crystallized during the whole summer without any evaporation by fire, solely by graduation, the hot brine is caused to pass ten or more times over these ropes.

which is detrimental to the boiling process. Graduation, consequently, is limited to the more propitious time of the year, and can then only be practised from 200 to 260 days; and the quantity of brine allowed to flow over the fagots must be proportioned to the power of the wind. Nevertheless, a considerable loss is unavoidable during the graduation, (12.4 per cent. at Schönebeck,) which is partly occasioned by small drops being blown away, and by salt evaporating with the water. At Nauheim, a glass plate, removed at the distance of 600 feet from the building, and placed upon a high pole, was found covered, after some time, with a thin incrustation of salt.

The changes which the brine undergoes in passing through the fagots are various. The carbonates of the earths are dissolved in the brine as bicarbonates; all the free carbonic acid, and half of that combined with the earths, escapes, partly in passing through the pumps, and still more during graduation; and the earths are deposited as insoluble simple carbonates, whilst the greater portion of the gypsum crystallizes in consequence of the diminished amount of water.* In consequence of these depositions, the thorns become gradually covered with a thick coating, (thorn stone,) consisting of carbonates of lime, magnesia, manganese, and protoxide of iron, with traces of metallic chlorides in variable proportions, which, inasmuch as it at last fills up the interstices and stops the draught of air, renders it necessary to renew the thorn wall every five, six, or eight years. In the brine cisterns, precipitates of like composition fall as a fine mud, sometimes accompanied by a greyish, thick, scum-like mass, filled with bubbles, which is mostly composed of living infusoria evolving large quantities of pure oxygen. The principal change which takes place in the brine is naturally the progressive evaporation of the water; and the manner in which this progresses, although variable on account of locality and the weather, may be seen from the following view of the graduation at Dürrenberg: A cubic foot of brine contains of salt—

	Pounds.
In the beginning	2.5
After the first graduation	3.9
After the second graduation.	5.6
After the third graduation	8.0

The climate of our Middle States is more favorable to the system of graduation than any part of Germany, and equal to any portion of France. The experience of those two countries is, that brines can be brought to the point of saturation without fire-heat at a cheaper rate than with it, even if cheapness were the paramount object, which should not be. Moreover, the brine is well fitted for making good salt when it goes through the solar process of evaporation, which we have designated the French method, or through a process analogous to graduation, as pursued in Germany and in parts of Italy and France. This fact has been acknowledged by the scien-

*Gypsum, according to Berthier, is most soluble in a brine of specific gravity 1.033, and is, therefore, not deposited at first from very weak brine.

tific men of Great Britain for the past half century. From the coolness and humidity of that country, they declare the inability of their people to make a good and safe antiseptic salt as cheaply as they can buy it. England makes salt only for the arts, for manure, and for exportation. Even what has been done in Massachusetts, and what is now doing at Onondaga, proves that good solar-made salt can be manufactured anywhere in the United States as cheaply as boiled. The saving to this country would count by millions of dollars if all the salt produced in New York and the Kanawha Salt Basin were of the kind and quality of the 500,000 to 700,000 bushels of solar-made salt now manufactured at Onondaga, even if it should cost more than boiled, which it need not.

A word more as regards salt-making in the drier and hotter parts of our country. The most favorable localities of the eastern coast of the United States for salt-making by solar evaporation, without aids analogous to graduation, are on the coast of Texas, from the mouth of the Rio Grande to Galveston Bay, and more especially around Corpus Christi Bay; the average annual fall of rain in the last-named region probably not exceeding 30 inches. Yet, from the shallowness of the water on the coast, it is difficult to find places where salt can be made and shipped cheaply.

The Keys along the Florida Reef also furnish many situations where solar-made salt can be produced and shipped to great advantage. The climate may not be quite so dry as the southern coast of Texas, but this region generally furnishes superior facilities for shipping. For nineteen years previous to 1850, the fall of rain at Key West, at an annual average, was 31½ inches, but since then it has been greater. However, the experience of the writer of this article goes to prove that millions of bushels of the best solar-made salt can be yearly manufactured along this Reef, if the proper system be adopted, and due care be taken to purify and crystallize the brine. In two or three instances, I have crystallized salt in six weeks from sea-water, by the solar method. The brine traversed about 15 miles, and was up to saturation by the time it had arrived at the last receptacle in the series, at which point, it was pumped into carefully prepared crystallizing pans, situated on a higher level than the others. Besides hastening the evaporation, keeping the brine in slow motion seems to aid in depositing impurities. One unacquainted with the business would be astonished at the quantity of impurities deposited from sea-water by this plan. In strengthening from 6° to 12°, Beaumé, the brine precipitates a grey slimy mass, mixed with organic matter, and gives forth sulphuretted hydrogen. Further strengthening from 12° to 22°, it precipitates crystalline sulphate of lime chiefly, and during this period bromine shows itself, especially if a little rains falls in the brine. This brings out the color to such a degree as to tinge various substances which come in contact with it. At 25° the brine stands at saturation, and crystallization is more perfect if it be kept in slow motion during the process. I have found it necessary to give great attention to the bottoms of the pans, to prevent the mixing of marl and lime-sand with the salt during the process of raking. But the greatest expense

of salt-making and preparing for market here consists in raking the salt from the pans, housing and protecting it from the weather, and delivering it to vessels. These items constitute seven-tenths of the whole expense. This shows the necessity of selecting convenient points for housing and shipping. Even in these hot and dry regions, many aids to evaporation may be adopted with advantage, such as throwing the brine in showers on high piles of brush, and letting it flow over sloping surfaces of bare rock, according to the nature of the locality. Much brine that is saturated, or nearly so, may be saved, just before the summer rains commence, by pumping it into large tanks, where it can remain covered till the period arrives for crystallizing it on perpendicular ropes, as already described.

It is probable that sea-water from different parts of the ocean produces salt of unequal value. The fact is noteworthy that salt made from water of the Gulf Stream, which is used here, is held to be of superior quality, though it is certain that, in many places, this salt is manufactured with the greatest carelessness.*

In Germany, they use a process by which a superior kind of salt must be obtained. After the saturated brine is heated, it is pumped into small tanks, which are arranged around the top of a frame from 20 to 30 feet high, and of suitable size, on the ground, from which, ropes are suspended perpendicularly, about 6 inches apart. On these the brine from the tanks is caused to flow in small streams, where it rapidly crystallizes. In twenty-four hours, the ropes become so loaded with salt that it requires to be knocked off. One would think this a wasteful process; but Dr. Ure says: that, with care, it is not so, and my own experience confirms his statement. He further says that as much can be effected by this plan in twenty-four hours as by the other in three days. And this process of crystallizing must turn out a purer article than even by the slow, careful manner of effecting this in the pans, for the reason that all impurities of other salts are immediately drained off from the ropes when rejected by the forming crystals of salt, and have no chance to adhere to the surface, nor to fill a casual interstice, as is likely to be the case in other plans of crystallization.

As sources of supply of common salt to the United States, neither France nor Germany is of much importance, as we import very little from either.

In Spain, Portugal, and their dependencies, the process for making salt is still very imperfect. The water is let directly into the pans, or ponds, from whence salt is raked, without attempting to precipitate the impurities from the brine, or to hasten the period of raking by concentrating the evaporation of the whole works on a few of the last pans, in a series as above described, the superior dryness of the climate rendering this not absolutely necessary. In consequence of this, the common salt crystallizes in a half-floating mass of impurities and brine, impregnated with iodine and bromine, which last substances give a disagreeable sharpness and acridness to the salt, so

* Water from the Gulf Stream, at Key West, varies in strength from $4\frac{1}{4}^\circ$ to 5°, Beaumé, at different seasons, which is probably caused by rain water remaining on the surface for some time without mixing, or by the fresh water brought down the Mississippi and other streams.

much complained of in England. Even the St. Ubes, which is somewhat better in quality, is manufactured with much the same carelessness. At the works in that vicinity, the pans are kept full of sea-water during the rainy season, to prevent the bottoms from becoming fresh, and we are informed that but little trouble is taken to clean the pans, at the beginning of the dry season, from the vast slimy deposit of the previous five or six months, the most of which, from the difficulty of cleaning it out, remains in the pans as an addition to the impurities that are deposited by the sea-water during the salt-making season proper. Salt crystallized in such a bed must drain and dry for a year or more before it is fit for use, and even then, it does not lose its sharpness of taste. These countries are extensive but variable sources of supply of solar-made salt to the United States, we having imported from Spain, Portugal, and their Islands, in 1856, 1,614,456 bushels.

At Turk's Island, some of the Bahamas, St. Kitts, and St. Martin's, with a few of the other British West India Islands, excellent salt is made at works where the French plan is carried out in part or in whole; but at many (probably a majority) of the works on those Islands the same carelessness prevails as with the Spanish and Portuguese. But it is difficult to ascertain with certainty the system or systems adopted in those Islands in consequence of salt-making having greatly declined in Turk's Island since 1833, which was formerly one of the chief sources of supply of solar-made salt to the United States; and having sprung up recently in the Windward and some other of the British West India Isles, the isolation of which renders the sources of information uncertain.

As a source of supply of solar-made salt, these Islands have been hitherto of the first consequence, we having imported thence, in 1857, 1,033,601 bushels.

We occasionally receive cargoes of solar-made salt from Curaçoa, Yucatan, and a few other places, in the Carribean Sea and the Gulf of Mexico, all of which passes under the general name of Turk's Island; and which, whatever may be its appearance, is unquestionably unequal both in strength and purity.

Thus we have given a rapid view of the principal sources of supply of common salt consumed in the United States, with something near the quantity received from each source, and the methods of manufacture at some of the chief places.

It has been said that the amount of common salt consumed by a people indicates, in a measure, their comfort and prosperity. In our case, the sign holds good. About the end of the last century, it was estimated that in the provinces of France where they had purchased an exemption from the *gabelle*, or salt duty, the consumption of salt was 19½ pounds to each inhabitant, yearly; in other provinces, it was less; at the same time, it was estimated at 22 pounds in England. In our country, we consume more than 50 pounds to each person, annually.

The following is a statement of the quantity of salt imported, exported, and foreign salt consumed in the United States, in each year, from 1820 to 1857, deduced from official sources:

Statement of the quantity of salt imported, exported, and foreign salt consumed in the United States, in each year, from 1820 *to* 1857.

YEARS.	SALT IMPORTED.		FOREIGN SALT EXPORTED.		FOREIGN SALT CONSUMED		DOMESTIC SALT EXPORTED.	
	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.
Year ending September 30, 1821	3,943,727	$609,021	31,440	$15,321	3,912,287	$593,700	....	....
Do.......do......1822	4,087,381	625,932	24,328	12,391	4,063,053	613,541	....	....
Do.......do......1823	5,127,657	740,866	51,707	17,330	5,075,950	723,536	....	....
Do.......do......1824	4,401,399	613,486	57,763	17,666	4,343,636	595,820	....	....
Do.......do......1825	4,574,202	589,125	70,584	19,445	4,503,618	569,680	....	....
Do.......do......1826	4,564,720	677,058	30,680	8,603	4,534,040	668,455	....	....
Do.......do......1827	4,320,489	535,201	65,335	16,014	4,255,154	519,187	....	....
Do.......do......1828	3,962,957	443,469	37,808	10,718	3,925,149	432,751	....	....
Do.......do......1829	5,945,547	714,618	44,390	11,389	5,901,157	703,229	....	....
Do.......do......1830	5,374,046	671,979	101,866	20,064	5,272,180	651,915	47,488	$22,978
Do.......do......1831	4,182,340	535,138	55,689	13,353	4,126,651	521,785	45,847	26,848
Do.......do......1832	5,041,326	634,910	29,350	9,188	5,011,976	625,722	45,072	27,914
Do.......do......1833	6,822,672	996,418	44,570	14,501	6,778,102	981,917	25,069	18,211
Do.......do......1834	6,038,076	839,315	50,495	13,219	5,987,581	826,096	89,064	54,007
Do.......do......1835	5,375,364	655,097	99,249	20,492	5,276,115	634,605	126,230	46,483
Do.......do......1836	5,088,666	724,527	29,081	8,178	5,059,585	716,349	49,9[illegible]7	31,943
Do.......do......1837	6,343,706	862,617	41,118	12,722	6,302,588	849,895	99,133	58,472
Do.......do......1838	7,103,147	1,028,418	37,260	16,120	7,065,887	1,012,298	114,155	67,707
Do.......do......1839	6,061,608	887,092	40,857	16,778	6,020,751	870,314	264,337	64,272
Do.......do......1840	8,183,203	1,015,426	31,999	11,525	8,151,204	1,003,901	92,145	42,246
Do.......do......1841	6,823,944	821,495	72,912	23,466	6,751,032	798,029	215,084	62,765
Do.......do......1842	6,178,743	841,572	51,340	16,624	6,127,403	824,948	110,400	39,064
Do.......do......*1843	5,454,577	710,489	37,032	10,236	5,417,545	700,253	40,678	10,262

*This is only for nine months of 1843, when the 30th of June was established as the termination of the fiscal year.

STATEMENT—Continued.

YEARS.	SALT IMPORTED.		FOREIGN SALT EXPORTED.		FOREIGN SALT CONSUMED.		DOMESTIC SALT EXPORTED.	
	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.	Bushels.	Value.
Year ending June 30, 1844	8,243,139	$911,512	57,121	$19,400	8,186,018	$892,112	157,529	$47,755
Do do 1845	8,543,527	898,663	67,667	15,304	8,475,860	883,359	131,500	45,151
Do do 1846	6,423,317	768,682	57,766	20,116	6,365,551	748,566	117,627	30,520
Do do 1847	7,235,508	893,502	45,242	14,631	7,190,266	878,971	202,244	42,333
Do do 1848	8,969,604	1,042,502	39,379	14,846	8,930,225	1,027,656	219,145	73,274
Do do 1849	11,622,163	1,438,981	46,886	14,452	11,575,277	1,424,529	312,063	82,972
Do do 1850	11,224,185	1,237,186	31,046	9,668	11,193,139	1,227,518	319,175	75,103
Do do 1851	8,681,176	1,047,890	76,556	22,590	8,604,620	1,025,300	344,061	61,424
Do do 1852	10,116,080	1,112,137	44,490	9,745	10,071,590	1,102,392	1,467,676	89,316
Do do 1853	10,066,981	1,059,432	48,124	17,855	10,018,857	1,041,577	515,857	119,729
Do do 1854	10,158,376	1,310,935	60,557	19,960	10,097,819	1,290,975	548,185	159,026
Do do 1855	12,926,234	1,718,980	104,416	26,393	12,821,818	1,692,587	536,073	156,879
Do do *1856	15,405,864	1,991,065	126,427	36,784	15,279,437	1,954,281	698,458	311,495
Do do 1857	17,165,704	2,032,583	†131,737	41,218	17,033,967	1,991,365	†576,151	190,699

* Of the amount of boiled salt imported this year, 11,113,501 bushels were from England.

† It will be observed that, although our exports of salt have steadily increased, their amount never has been of great importance, being more accidental than from any facility of salt-making in the country. They are chiefly carried to the part of Canada bordering on and west of New York, and principally consist of boiled salt made in that State.

BREAD CROPS.

CHARACTERISTICS OF WHEAT.

[Condensed from "The Farmer's Magazine," London.]

The general diffusion of wheat over so large a portion of each hemisphere is a peculiarity which entitles it to the first consideration. Other Cereals, such as rice or maize, have only a local importance; but wheat is comparatively the "staff of life" throughout the vast regions of the earth lying between 60° north and 60° south of the equator, with the exception of a belt on each side of the line and within the tropics, where, even, it is cultivated with success among the highlands at certain elevations on the sea-board. Before treating of what relates to the natural history, the production, and the commerce of wheat, showing its beneficial and extensive influence on society, from the first committal of the seed to the earth to the manufacture of its produce into the staple articles of food, let us show its moral and social characteristics, as bearing in its use on the progress of civilization. The operations and arrangement of Nature in the formation, support of life, and final disposal of the animal as well as of the vegetable creation, have been uniform and continuous from the foundation of the world. The earth is the acknowledged "mother" of all living things, and the source from whence they derive the means of a prolonged existence; and when the mission to which they were appointed is fulfilled, it is to her bosom that, in one form or other, they are again consigned. Nor is man, "the lord of the creation," able to boast—so far at least as his material nature is concerned—a higher origin, a more refined source of sustentation, or a more noble end. Although, through the wisdom and goodness of his Maker, who "breathed into him the breath of life," a distinguished *status* has been appointed for him in the sphere of the material world, and a still more exalted destiny hereafter, these superior advantages, in no respect, have exempted him from the ordinary laws of organic existence. Respecting him, also, the decree has gone forth—"Dust thou art, and unto dust shalt thou return;" and in accordance with this fiat, he enters upon life in feebleness, like the rest of the animal tribes, rises, flourishes, and decays; and when his mission is accomplished, and the time allotted to him expired, his mortal remains resolve themselves again into their original elements, and mingle with the common mass of inorganic matter, to re-appear at some future period in new forms of utility and grace.

It was wisely ordained that man should subsist on the fruits of his own labor; that the bounteous universal parent should yield her stores only to the exercise of the skill and industry of the being whose superior powers and faculties have given him dominion over the land and sea; and that on the persevering and intelligent appli-

cation of those powers should depend, as a general rule, the amount or degree of benefit he should derive from those stores. ''The hand of the diligent maketh rich, but the sluggard lacketh all things.'' And thus, by a just retribution, whilst the use of the talents bestowed upon man brings its own reward, its neglect entails poverty and want, misery and distress, in all their complicated and destructive forms. It is now a well-established fact that, in proportion as civilization has extended, human food is improved in quality, and increased in quantity and variety. The investigations of science, and the enterprises of commerce during the last century have thrown great light upon this subject, by revealing the condition of the nomadic tribes in different parts of the globe. In regions further removed, or wholly shut out from intercourse with civilized life, not only is the mode of existence so precarious as to exclude the possibility of the natural increase of the species, but the means of sustaining life are often of the most disgusting and repulsive description. Thus, in Australia, such are the exigencies of human existence that worms, grubs, and even nauseous reptiles are the common food of the natives, who are found to be wholly destitute of a knowledge of agriculture, even in its most simple form. This, perhaps, is the most extreme case of barbarism of which, at present, we have any knowledge; but as we ascend from them, we shall find the degree of that condition distinctly marked, and rising as the food becomes more choice, abundant, and varied; while, in the state of utter barbarism, the precariousness of the supplies places the wandering tribes between the extremes of to-day's excess and to-morrow's destitution, those higher efforts of the mind which dictate reserve in the first case, as a provision against the second, are as dormant as if they had no existence.

Agriculture is the precursor of all the arts of civilization, the foundation of commerce, and the basis of national wealth. Of itself, it implies a property in the land, whether permanent or temporary, which at once raises the possessor in the scale of society. Closely connected with pastoral life, but more humanizing, it was practised by the patriarchs from the earliest ages ; and we may trace its ameliorating effects in the history of those venerable men. Where, even in the present day, can we find more real refinement of manners, more benevolence, or more sterling integrity and independence than were displayed by Abraham in the purchase of the land for a burial-ground, or in his yielding to his younger brother Lot the choice of pasturage for his cattle? What can be more touchingly fine than the salutation of Boaz to his reapers, or his injunction to them to ''drop the handfuls of ears'' for the poor widow's daughter? In the oldest history extant, such instances are numerous.

But to return to our times: with the advance of agriculture towards a science, we find an improvement in the character of those who conduct it. Herein Great Britain, in proportion to her extent, has taken the lead of all the world, and has both cultivated and consumed the largest amount of the most expensive products of the earth, particularly of wheat; and we find a corresponding amount of intelligence and civilization as the result. In Ireland, the potato, for many years,

constituted almost the only food of the rural population. The consequence of thus living on one kind of food, was to lower the social standard of character, and to deaden that spirit of enterprise which is an essential element in individual as well as national prosperity.

On the Continent of Europe, the lower classes subsist chiefly on the inferior Cereals, as maize, rye, barley, oats, buckwheat, &c. Even in France, the farmers who cultivate the wheat are generally too poor to eat it, except in its coarser form, and mixed with inferior grain. This is shown by the consumption of wheat in that country, which, with a population of 36,000,000, is about 136,000,000 bushels; whilst in England, with a population of 27,000,000, the quantity consumed is at least 168,000,000 bushels. In the central and northern provinces of Russia, and in Norway, rye and buckwheat constitute the principal food of the majority of the inhabitants, and, at times, a coarser food is prepared from the bark of certain trees, which, although to a small extent nutritious, is anything but palatable, and can only be tolerated in a country where civilization is at a low ebb. In Germany, wheaten bread is only eaten by the upper classes, rye and barley constituting the principal food of the rest. In the countries more south and east, maize is substituted, in a great measure, by the lower classes for rye, &c.; for, although wheat is grown in considerable quantities, it is too great a luxury for any but the rich, and what they do not consume is exported to England or France. In many parts of Asia, wheat may be, and is, grown to a certain extent, but it does not constitute the food of the masses of the people. In Persia and Northern India, Arabia, Nubia, Egypt, and Barbary, although great quantities are produced, particularly in the Delta of the Nile, maize, rice, and millet are the principal food of the people. In these genial climes and fertile lands but little skill or industry is required to produce a crop. In Egypt, after the subsidence of the waters of the Nile, the seed-wheat or barley, &c., is scattered over the mud. If this has become dry, the seed is lightly ploughed or harrowed in, and no more labor bestowed upon it until harvest arrives. The produce is very great, but here, also, its consumption is confined to the wealthy.

In China and Japan, rice is the chief food of all classes. The land is well cultivated in these countries, and agriculture has been especially promoted by the Chinese Government for many centuries. In some respects they have been in advance even of English agriculturists, as, for instance, in draining the lowlands by simple hydraulic means, and collecting the water, thus raised, into canals for the purpose of irrigating the uplands. The beneficial influence of this attention and respect to agriculture is seen in the high degree of civilization to which that people have attained, different, it is true, from that of Western Europe, from causes unnecessary to refer to here, yet which raises them far above many of the European States in social economy. The immense population, however, of that empire chiefly subsist on rice; while the richer classes, in addition to that grain, indulge in an endles variety of luxuries. The restriction of the former to so inferior a species of food has the effect of repressing and degrading

the mind. In Africa, rice and maize are used by the majority of the people, indiscriminately, with the exception of Egypt and Nubia.

In South America, with the exception of Venezuela, Chili, and Peru, maize is almost the only food of the great body of the natives; and even in North America, especially in the United States, the same grain is generally eaten, as well as wheat. But the abundance of other kinds of food, and the variety of ways in which maize is prepared in the last-named country, render its use, even if it were more exclusive, less influential upon the manners.

We have thus, very slightly, surveyed the means of subsistence of the principal countries of the globe; and if the history of the condition of each be considered in connection with the quality of the food by which the greater part of its inhabitants are sustained, we must come to the conclusion, either that the political and social condition of the people compel them to have recourse to the most ordinary description of food, or that the use of it tends to lower and enslave the mind; whilst a more healthful and expensive diet would have a corresponding beneficial effect. It is probable that both these causes may operate at once, and upon each other. But it is nevertheless certain that the use of the most generous diet has an elevating effect upon the mind, and that in this respect, the general use of wheaten bread as the most nutritious vegetable food, in substitution for a less expensive and less wholesome one, wherever it has prevailed, has tended to elevate the character and condition of the people, and fit them for a better discharge of all the moral and social duties of life.

Wheat is both a biennial and an annual plant, the former being sown in the northern hemisphere, from June to November, and is usually called "fall or winter wheat," and the latter from February to April, and designated by the name of "March or spring wheat," according to the climate and elevation above sea-level in which it is cultivated. This plant has a double set of roots, namely, the "seminal" and the "coronal." The former spring from the germ of the seed, and nourish the young plant in its incipient stage, until the first knot of the stem or joint has acquired sufficient solidity and hardness to throw out the coronal roots, which invariably form just beneath the surface, when the wheat is sown to a proper depth, and, shooting obliquely into the soil, contribute to the nourishment of the plant. In a loose soil, the seminal roots strike downward to a considerable depth, and have been traced 6 feet below the surface, in a sandy soil, evidently in search of water. They are connected with the coronal roots by a pipe, which, in fact, is the first joint of the stem, the pipe being longer or shorter according to the depth at which the seed is buried in the earth. If this be superficial, no coronal roots are thrown out. This shows the advantage of deep as well as early sowing for winter wheat, whereby it is protected more effectually from those accidents to which it is liable, especially the "root-fall," occasioned by the frost laying bare the roots.

The choice of seed, in wheat, as well as in other plants, is a primary question. It is here that, in ordinary cultivation, farmers often deviate from Nature. The seeds of the wild wheat, except in a few instances, are sown where they are ripened. Unless conveyed by the winds or by animals, they are reproduced for a series of years on the same soil, in consequence of which the plant yields small seeds—perhaps degenerates. The farmer, to improve upon Nature, avoids these ill results by changing the soil; by carefully manuring his land; and by varying his seed. He notes, too, that in this alteration of seed, certain facts with respect to new wheat are to be regarded as benefits. The seed should always be chosen from a poor soil for the seeding of a richer one, and from a cold climate for cultivation in a warmer. By acting contrary to this rule, we induce disease and a shortness in the yield. In Gloucestershire the hill-farmer chooses seed from the exposed chalk Wolds of Wiltshire, while the vale-farmer procures his seed-wheat from the hills. But in the same manner as spring-wheat may be cultivated into a winter variety, so may any kind of wheat become acclimatized by careful cultivation, which, however, sometimes entails a slight change of form; and hence have arisen tall and dwarf varieties, early and late forms, &c. New varieties of wheat are constantly becoming in fashion with the agriculturist; but it must not be concluded that this is the result of caprice, as it is the nature of derivative plants to lose some of their qualities after a long career of changes; hence varieties are always useful as a change, and the more distinctive these are the better, if adapted to the climate and soil.

The variety of the seed-wheat, however, is not the only material consideration: the prevention of disease in it has long engaged the farmer's attention. He strives to prevent blight, and commonly with success, by immersing the seed in brine, or solutions of sulphate of copper, &c.; the beneficial effect of which he attributes, perhaps with correctness, to the fact that these substances kill the minute sporules, or seeds, of the fungi, which have attached themselves to the wheat, and are the origin of the parasites that constitute the blight. But the experiments upon this subject, by Professor Buckman, seem to warrant the conclusion that the beneficial action of these steeps depends upon their destroying the germinating power of malformed and diseased seeds; and he recounts some facts which he thinks show that the pickling of wheat destroys it, so as to prevent germination when the seed is diseased or ill-formed; but that, if perfect seed were always employed no pickling would be necessary, as diseased progeny must result from an imperfect stock in plants, as well as in animals.

The depth at which the wheat-seed is most beneficially placed is a question, in general, not very carefully regarded. If we follow Nature here, we shall find her seeds mostly dispersed, or germinating at, or near the surface; and it has been ascertained, in the case of some kind of seeds, that if shaded from the direct rays of the sun, they germinate better than in any other situation. As with our field operations, however, it is not possible to leave seeds thus exposed to

their various enemies, and as it is necessary to cover them with earth, the next inquiry which promises to be interesting is, what depth from the surface happens to be practically the best for wheat? Now, the experiments of Professors Buckman and Petri seem to concur in placing the depth at from one to two inches, as that possessing the maximum advantage. The result of the experiments of Petri is shown in the following table, who sowed given quantities of wheat at different depths:

SEED SOWN TO THE DEPTH OF—	Came above ground in—	Proportion of plants which came up.
½ inch	11 days	Seven-eighths
1 inch	12 days	All
2 inches	18 days	Seven-eighths
3 inches	20 days	Three-fourths
4 inches	21 days	One-half
5 inches	22 days	Three-eighths
6 inches	23 days	One-eighth

Here it may be observed that the number of plant-producing seeds decreased as the depth below an inch increased; and in some recorded experiments with barley a similar progressive rule was found, until, when sown at a depth of 12 inches, it entirely ceased to produce plants.

If the depth materially influences the germination of the seed, so, also, do the climate and the period of the year in which they are sown. In an experiment by Professor Buckman, who sowed the same variety of wheat (red Lammas) in plots on the same soil, in each month of the year, the results are tabulated as follows:

DATES.	Height.	Length of ears.	Remarks.
1851.			
June	3 feet 5 inches	3 inches	Clean straw
July	2 feet 10 inches	2 inches	Clean straw
August	4 feet 1 inch	4 inches	Clean straw
September	3 feet 11 inches	4 inches	Clean straw
October	3 feet 10 inches	4 inches	Rather blighted
November	3 feet 9 inches	4 inches	Rather blighted
December	3 feet 10 inches	3½ inches	Much blighted
1852.			
January	3 feet 10 inches	3½ inches	Much blighted
February	3 feet 6 inches	4½ inches	Much blighted
March			Failed as a crop, but some ears ripened
April			
May			

In the above experiment, it may be remarked that the winter was mild and wet, and that all the samples were gathered in August.

One of the characteristics of winter wheat is, that it sends out new roots and fresh fibrils in the spring, at the same time tillers and forms tufts, each shoot of which also takes root, like the central blade; and all this second growth occurs just when the spring wheat is coming up. In spring wheat, there is little disposition to tiller; as the growth is quick, the root has no period of rest, and therefore its fibres and fibrils are regularly developed, and have no fresh impulse of growth like wheat which has stood the cold winter, and is prepared to meet the milder season of spring with an invigorated constitution, and an appetite that requires new roots and fresh rootlets to supply it. It is on this account that winter wheat can be transplanted in spring with but little check to its growth, and even the tufts can be divided into slips which, indeed, may be a useful mode of augmenting a crop in experiments upon varieties rare and new.

When wheat has been sown as early as possible, at the required depth and at a proper season, the following changes take place: The grain begins to absorb moisture from the soil, and consequently increases in size. In a few days, the embryo becomes enlarged—the lower part soon protruding as a rootlet—the upper as a bud—which will quickly develop leaves. Coincident with this, proceed the chemical changes in the cotyledon, from which the germ is supplied with its food, until the roots on the one hand, and the leaves on the other, become capable of acting—the one as purveyors and the other as eliminators of the food with which the plant may be surrounded, in the soil and in the atmosphere, and upon which its after welfare depends. If wholesome food for the plant be in the soil, it progresses favorably; if the reverse, disease or dissolution will be the result. If the supply of this be insufficient, the produce will be small; if too great, the effect will be blighted leaves and straw, with too small a proportion of grain. If bad seed be sown, there will be a sickly and malformed plant, resulting in diseased and consequently blighted grain. All this, however, depends upon the nature of the air which the plants are compelled to breathe; if full of noxious vapor, they die. A small quantity of sulphuretted hydrogen, sulphurous acid gas, and muriatic acid gas, mixed with the atmosphere which comes in contact with the wheat plants, acts as a poison, and thus prevents them from being grown in the vicinity of certain chemical and manufacturing works, or from caverns, or other parts of the earth from which these gases are evolved.

On the subject of "tillering," it may be remarked that the *tillers spring from the seminal roots, but not from the coronal*, the latter of which has been confidently laid down by respectable authority. The latter, so far from being an essential appendage to the plant, are entirely accidental in their formation. They proceed from the first knot, or joint, formed in the stem, provided that knot is beneath the surface; but if, as is frequently the case, it is above the surface of the soil, more coronal roots are formed, and the plant is wholly supported by the seminal roots, which, in all cases, constitute its main organs of nourishment. The establishment of this fact greatly strengthens the arguments in favor of deep sowing, by which the chance of the forma-

tion of a joint below the surface is rendered more certain, and which also insures the formation of coronal roots. These, undoubtedly, are of great utility in imparting a more firm hold of the soil, as well as additional nourishment to the plant, and consequently lessen the danger of its being lodged.

The applicability of the system of the transplantation of wheat, and the separation of the tillers from the main stem, to the general practice of husbandry, is a question which requires time and consideration to solve. At present, the mind of the great body of agriculturists is engaged on the subject of machinery, stock-breeding, and under-drainage; and the more abstruse one of the physiology of plants, and the increase of their reproductive powers is confined to the application of various kinds of manures. The latter is certainly based upon chemical principles of very great importance, and being of easy solution, as well as of less complicated practicability, has been generally adopted. But the natural history of the powers and properties, the habits of plants and principles of vegetation are even of more importance than the quality and appropriateness of fertilizers; but owing to the thought and study they require, and the tediousness of the processes by which results are obtained, very few indeed will be found to give them attention; and successful experiments of those who have made the investigation are often suffered to fall to the ground. It is anticipated, however, that the time is not far distant when the reproductive powers of our Cereal plants, especially wheat, will become the great question of the age; and that it will be found quite possible to increase their produce above what is now obtained, to at least two-fold. It would be gratifying to see the attention not only of men of science, but that of the landed interest, or at least that portion of it which are most forward in agricultural affairs, directed to this question. The consumption of Cereal food is rapidly increasing throughout the civilized globe, and must continue to do so in geometrical ratio with the growth of population; and as the first law of Nature, "increase and multiply," is obeyed both in letter and spirit, one may look for the time when, without a proportionate production, the teeming millions will find difficulty in procuring bread.

D. J. B.

CHEMICAL ANALYSES OF INDIAN CORN.

BY CHARLES T. JACKSON, M. D., OF BOSTON.

Having been instructed by the Commissioner of Patents "to determine the per-centage of starch, dextrine, gluten, and oil contained in the grain of the King Philip, Tuscarora, Wyandott, and White Gourd-seed or Horse-tooth corns," I procured well characterized samples of those varieties of maize, and submitted them to chemical analysis for the separation of the above-named proximate principles. In addition to those, I was required by my instructions to separate,

I have determined the proportions of caseine, albumen, and glucose contained in the corn, believing the results would prove interesting, both to men of science and practical farmers.

In each analysis, about 600 grains of the corn were operated upon, in portions of 200 grains for each principal test. In one instance, the analysis was entirely repeated on a fresh sample of the King Philip corn raised last summer, the first analysis having been made on dry seed corn, in which I feared the oil had become desiccated, or oxydized. The specimens of Wyandott and Gourd-seed or Horse-tooth corn, were of last summer's growth. The Tuscarora corn was of the crop of 1856, grown near the borders of Connecticut River. The King Philip corn was obtained from Braintree.

KING PHILIP CORN.

This is an eight-rowed variety, and has a moderate-sized grain. The ears are long, slender, and uniform in size from base to tip. The grain has a deep orange color, and is a hard or flint-corn. It is very prolific, and much liked by our farmers on that account, and also for its quality of keeping sweet, when ground into meal. It is not suitable for starch-making, nor for rapid cooking, since it is very difficult to soften by the action of water.

The results of the analysis of a sample in a dry state were as follows :

Water	10.0	per cent.
Fat oil	4.0	"
Gluten, or zeine	5.0	"
Dextrine and glucose	1.5	"
Caseine and albumen	2.0	"
Starch	63.6	"
Cellulose	12.8	"
Undetermined, ash, &c	1.1	"
	100.0	

Another sample of the crop of 1857, from Braintree, gave :—

Water	12.9	per cent.
Fat oil	4.2	"
Gluten, or zeine	5.5	"
Dextrine and glucose	1.5	"
Caseine and albumen	2.1	"
Starch	54.5	"
Cellulose	17.3	"
Undetermined, ash, &c	2.0	"
	100.0	

WYANDOTT CORN.

This variety of corn is extremely beautiful, being perfectly milk white. It is twelve-rowed, with a medium-sized grain, very soft and

starchy, and having, as shown by analysis, but little cellulose in the form of epidermis and oil-cells. This corn grows admirably in the Southern and Middle States, and is especially adapted for the manufacture of corn starch, used chiefly for food and for making meal that may be quickly cooked. It is the best variety for feeding horses and cows, as it is so easily crushed by their teeth, and is almost wholly digestible.

The following are the results I obtained by analysis:

Water, separable at 212° F.	15.30	per cent.
Fat oil, soluble in ether	3.60	"
Gluten, or zeine, soluble in alcohol	4.80	"
Dextrine, soluble in water, &c	1.40	"
Caseine, precipitable by acetic acid	2.00	"
Albumen, coagulable by heat and by alcohol.	1.00	"
Glucose, (grape sugar,)	0.25	"
Starch, deposited from water	62.05	"
Cellulose, insoluble matter	6.30	"
Undetermined, ash, &c	3.30	"
	100.00	

The starch-maker will obtain by his processes between 50 and 60 per cent. of starch from this grain.

I would observe, that the meal of these white, soft, starchy corns is more liable to become musty and sour than that of the flinty corns, and that it is better to keep it in the ear in a dry place until it is wanted for grinding, when only that required for a week's use should be sent to mill.

These white, soft corns are best for rapid cooking into puddings and corn-bread, the meal cooking nearly as soon as that made of wheat flour.

TUSCARORA CORN.

This is an eight-rowed variety, but its grain is very large, and the cob proportionally small, and of a red color. The kernel is white, but not quite so pure as the Wyandott. It is preferred in New York to all other corn for making starch, and is raised expressly for that purpose. It may be advantageously raised in the Middle and Southern States, but is a rather late crop at the North, though it does not fail to ripen in seasons of average warmth and duration. Like the Wyandott, it will be found far better food for horses and neat cattle than any of the flint corns, and is much liked by those people who have used its meal in making puddings and bread.

My analyse, of specimens raised on the borders of the Connecticut river, in Massachusetts, gave the following results:

Water	8.2	per cent.
Oil	3.5	"
Gluten	4.8	"

Dextrine and glucose	1.7	per cent.
Caseine and albumen	3.0	"
Starch	66.3	"
Cellulose	11.5	"
Undetermined matters, ash, &c	1.0	"
	100.0	"

Another sample of the crop of 1857, from Braintree, was analyzed, and gave of—

Water	12.9	per cent.
Fat oil	4.2	"
Gluten, or zeine	5.5	"
Dextrine and glucose	1.5	"
Caseine and albumen	2.1	"
Starch	54.5	"
Cellulose	17.3	"
Undetermined, ash, &c	2.0	"
	100.0	"

GOURD-SEED OR HORSE-TOOTH CORN.

The gourd-seed or horse-tooth corn is an eighteen-rowed Southern variety, with pitted grains, from the contraction of the starch in drying The ear is short, stumpy, and closely packed with grain. The kernels are very large, and hence its name. They are nearly white, and the flinty portion of the grain on its sides is transparent and nearly colorless.

A specimen of Virginia growth yielded on analysis—

Water	18.20	per cent.
Fat oil	2.90	"
Gluten, or zeine	2.10	"
Dextrine and glucose	2.65	"
Caseine and albumen	1.35	"
Starch	53.50	"
Cellulose	17.50	"
Undetermined, ash, &c	1.80	"
	100.00	'

It is probable that this corn had not been so thoroughly dried as the other samples I have analyzed, and that, when kept under the same conditions as the Wyandott, it would not yield more water than that variety. Analysis shows, however, that it is not so nutritious as the other varieties here reported.

The following table shows the results of the foregoing analyses, in order that they may more readily be compared with each other:

Resumé of the per-centage in the preceding analyses.

VARIETIES.	Water.	Oil.	Gluten.	Dextrine and glucose.	Caseine and albumen.	Starch.	Cellulose.	Undetermined, ash, &c.	Remarks.
Wyandott, from Washington.	15.3	3.6	4.8	1.65	3.0	62.05	6.3	3.3	The dextrine, glucose, albumen, and caseine are here given together, though separated in analysis, as shown in the tables.
Tuscarora, from Massachusetts.	8.2	3.5	4.8	1.7	3.0	66.3	11.5	1.0	This sample, which was quite dry, was raised in 1856.
King Philip, from Rhode Island.	10.0	4.0	5.0	1.5	2.0	63.6	12.8	1.1	This corn was dry, and of the crop of 1856.
King Philip, from Massachusetts.	12.9	4.2	5.5	1.5	2.1	54.5	17.3	2.0	This sample was raised in 1857, and had not been kept in a dry room.
Gourd-seed, or horse-tooth, from Virginia.	18.2	2.9	2.1	2.65	1.35	53.5	17.5	1.8	This corn had not been kept in a dry room; was raised in 1857.

ANALYSES OF THE CHINESE YAM, MERCER POTATO, AND CHUFA.

BY CHARLES T. JACKSON, M. D., OF BOSTON.

In accordance with instructions from the Commissioner of Patents, I have determined the proportions of starch in the Chinese yam, (*Dioscorea batatas*,) and in the Mercer potato; also the amount of nutritious matter contained in the Chufa, or "Earth Almond" (*Cyperus esculentus.*)

CHINESE YAM.

I find the Chinese yam to contain the following ingredients:

Water	80.52	per cent.
Starch	9.93	"
Cellulose and fibrous matter	3.65	"
Sugar	0.45	"
Fat oil	0.12	"
Albumen	1.27	"
Mucilage, (gum,)	3.20	"
Mineral matter, (ash,)	0.86	"
	100.00	"

I present this full analysis, believing it will prove valuable to the public, and interesting in science.

MERCER POTATO.

The Mercer potatoes submitted to me for analysis for starch were obtained in January last. This esculent, though excellent for cooking, is not adapted for starch-making, since it changes color by atmospheric exposure, and the dark-brown coloring matter is very difficult to separate from the starch.

I found 100 parts, by weight, of these potatoes to yield—

Water	75.80	per cent.
Starch	12.54	"
Cellulose	3.62	"
Other matters not separated	8.04	"
	100.00	

CHUFA.

The chufa, a curious and, as I believe, valuable plant, has interested me greatly, an I have made a very minute analysis of its tuberous roots, which, from their composition, must be regarded as highly nutritious, both for man and animals.

The following are the results:

Water	15.50	per cent.
Fibrous matter	21.45	"
Starch	27.00	"
A peculiar sugar, (like manna,)	12.25	"
Wax	0.50	"
Fat oil	16.65	"
Mucilage, or gum, with a little albumen	6.65	"
	100.00	

When these tubers are beaten to a paste, and mixed with water, a remarkable emulsion is formed, which, after straining, resembles milk in appearance. The fat at length rises to the surface, and looks like cream, while most of the starch subsides to the bottom of the vessel, but enough still remains suspended to give the emulsion the appearance of thin or skim-milk. Thus mingled with water, the most nutritive ingredients of this plant may be taken as a drink. It is much used in this manner by the Spaniards, and I have no doubt will be so employed in this country. This emulsion may be sweetened and flavored so as to make it very agreeable to the taste.

The chufa tubers cannot fail to prove a most valuable fattening food for animals, and they are much relished by swine and poultry. It is practicable to obtain a considerable proportion of oil from these tubers by pressure, after which the remaining cake will still serve as a valuable food for stock, and add to the richness of the milk, if fed to cows.

TEA-CULTURE.

ON THE PRACTICABILITY OF THE TEA-CULTURE IN THE UNITED STATES.

That an article so generally regarded as a prime necessity by every civilized nation should be restricted in its production for centuries almost entirely to the country of its origin, although corresponding regions with respect to soil and climate have been open to its introduction and culture, is an anomaly in the physical and social history of the globe. The tea of China, though acknowledged by most persons as a luxury, and by some even as food, is a commodity from which the people of no country should be deprived. On the contrary, it may not be improper to repeat what was stated in a former volume, that in this case, as well as in most others, it is the policy of every government to gratify the wishes of its people, and to facilitate the acquisition of this luxury by its economical importation, or, what would be far more desirable, to extend the production to its own soil.

As to the expediency in the United States of such a measure as that last named, little more need be said than that most of our citizens will have it, cost what it may, and millions of dollars will annually be paid for its importation, until its extensive culture shall be established in our soil.

From the supposed general resemblance of the soil and climate of the tea districts in China, and those of certain regions in our Southern States, various attempts have been made by private individuals to introduce this plant, which, in all cases, ultimately resulted unsuccessfully, either from accident or the want of an adequate knowledge of its culture, but more particularly of the manipulation of the leaves when grown. Thus, tea was introduced into Georgia in the year 1772, and more recently into South Carolina in 1848 and 1852.

GEOGRAPHY, SOIL, AND CLIMATE.

In the event of the successful introduction of tea-culture into this country, it will first be necessary to acquire a more accurate knowledge of the soil and climate of the regions which produce tea in China or India, and then to select localities possessing similar conditions of soil and climate in the United States. Although the dominions of the Emperor of China extend over twenty-three degrees of latitude—from 18° to 41° N., and twenty-five degrees of longitude, from 98° to 123° E.—embracing a soil varied in surface, elevation, and composition, and a climate purely tropical as well as temperate and Alpine, until quite lately the culture of the tea shrub has been confined principally to that portion of the territory lying between latitude 25° and 31°, and the best tea districts are those between 27° and 31°. This part of the empire has been represented as wholly under cultivation, but, on the contrary, more than half of it lies in a state of Nature, and has never been disturbed by the hand of man.

The tea-plant is not only found in China and Japan, chiefly in a cultivated state, but is indigenous in the mountains which separate China from the Birmese Territories, especially in Upper Assam, bordering on the Province of Yun-nan. It is also cultivated in Nepal, at an elevation of 4,784 feet above the Bay of Bengal, in latitude 27° 42′ N. Within a few years, the government of British India has introduced tea cultivation into the North-western Provinces and the Punjob. At the present time, there are about 1,500 acres under cultivation in these districts. The tea manufactured is all sold in India, and brings high prices at the government sales, when it sometimes sells for 6*s*. or 7*s*. (from $1 50 to $1 75) per pound. From the success which has been met with in the above-named Provinces, as of the Assam Tea Company, this plant is now beginning to be cultivated by private individuals. For the last twenty years, tea of fair quality has also been produced in considerable quantities in Brazil.

In order that the reader may form an opinion of the soil and climate requisite for the culture of tea, the following abstract has principally been made from "Two Visits to the Tea Countries of China

and the British Tea Plantations in the Himalaya," published in 1853, by Robert Fortune, the gentleman to whom reference is made in another part of this volume.

In beginning with the Southern Provinces, which, of course, are tropical, and differ in many respects from those of the North, both with regard to the soil and the nature of the plants cultivated, it may be stated that the land on the mountains is of the poorest description. Rocks of granite are seen everywhere protruding themselves above the scanty vegetation, whilst the soil itself is composed of dry sunburnt clay mixed with particles of granite in a decomposing or disintegrated state. Nearly all the hilly portions of the south of China are in a state of Nature, "stern and wild," where the hand of man never attempts agricultural operations, and where it is almost impossible he ever can. Here and there, near the base of the hills, the far-famed "terrace cultivation" may be seen, where the natives grow small patches of rice and other vegetables, such as sweet potatoes, pea-nuts, &c., but the quantity of land in this part of the country, used for such purposes, bears but an extremely small proportion to the vast tracts in a wild state. At Amoy, and over all that part of the Province of Fokien, the mountains are even more barren than those of Quan-tung. On some of the hills, on the island of Amoy, one may wander for miles scarcely seeing a weed. On every side, there is nothing but masses of dark crumbling granite and red, burnt-looking clay. This, however, seems to be the northern boundary of the most sterile part of the empire.

On reaching the river Min, near Foo-chow-foo, there is a great change visible in the vegetation of the hills, caused by the richer components of the soil. This remark applies to the northern portion of Fokien, and to the whole of the Province of Chekiang. Hills occur near the mouth of the Min, at least 3,000 feet above the level of the sea, which are under cultivation quite to the summit. The soil here is composed of a gravelly loam; and, though far from rich, is much deeper and contains more humus, or vegetable mould. The addition of this vegetable matter renders the land sufficiently fertile to repay the Chinese farmer for the labor expended in bringing the crops to maturity. Some hills, of course, are much more productive than others. The tea districts, for instance, both in the Provinces Fokien and Chekiang, are not only more fertile, but are very different from what they are often supposed to be.

The soil of the valleys or plains varies quite as much in different Provinces as it does on hills. The level of these valleys or plains is generally very low, in many cases lower than that of the rivers and canals.

About Canton and Macao, and in fact over all the Provinces at the South, unless, perhaps, in the vicinity of large towns, where the natural character of the soil has been altered to a certain extent by the influence of manure, it consists of a strong stiff clay, mixed with a small portion of sand, but containing scarcely any vegetable mould. As the hills lose their barrenness, 400 or 500 miles to the northward from Hong-kong, a visible change also takes place in the soil of the valleys

and plains. In the district of Min, for instance, instead of being almost entirely composed of strong stiff clay, it is mixed with a considerable portion of vegetable matter, and is an excellent strong loam, capable of producing good crops. As a general rule, it may be observed that the lower the valleys, the more the soil approaches in its nature to the stiff clay of the South, and *vice versâ*. For instance, the Shanghae district is several feet higher than the level of the rivers and canals. and than that of Ningpo, and the soil of the latter consists more of a stiff clay, with less vegetable matter in its composition, and is far from being so fertile as the cotton region of Shanghae.

The soil of Sung-lo, or Sung-lo-shan, a hill, or mountain, elevated from 2,000 to 3,000 feet above the level of the plains, famous in China as being the place where the green-tea shrub was first discovered, is very barren, and, whatever formerly may have been the case, certainly produces but little tea now. But the low lands of this district, and those of Mooquen, situated a few miles further south, produce the greater part of the fine green teas of commerce; hence the distinction between "hill-tea" and "garden-tea," the latter simply applying to those teas which are carefully cultivated in the plains. The soil here is a rich loam, not unlike that of the cotton lands of Shanghae, but more free in its texture, being mixed with a considerable portion of sand. The rocks in this part of the country chiefly consist of Silurian slate, upon which rests a red, calcareous sandstone similar to the new red sandstone of Europe. This sandstone, as it crumbles to pieces, has the effect of giving a reddish tinge to the barren hills.

Some 200 miles east of Sung-lo is the beautiful island of Chusan, which is about 20 miles in length and 10 or 12 miles in breadth at the broadest part, and consists of a succession of hills, valleys, and glens. The soil of the hills is a rich gravelly loam; in the valleys, it is more stiff, from having less vegetable matter mixed with it, and from being almost continually under water. The rocks of granite, however, of the same kind as those noticed on the barren southern hills, also exist here; and, although they are generally covered with soil and vegetation, they have doubtless been at some former time as bleak and barren as those of Quan-tung.

On entering the Bohea tea-lands about Woo-e-shan, it is found that the soil varies considerably. The rocks consist of clay-slate. in which occur, disposed in the form of beds or dykes, great masses of quartz, while granite of a deep black color, owing to the mica it contains, which is of a fine, deep, bluish-black, cuts through them in all directions. This granite forms the summit of the principal mountains in this part of the country. Resting on this clay-slate are sandstone conglomerates, formed chiefly of angular masses of quartz, held together by a calcareous base; and alternating with these conglomerates, there is a fine calcareous, granular sandstone, in which beds of dolomitic limestone occur. The soil of these tea-lands consists of a brownish-yellow adhesive clay, which, when minutely examined, is found to contain particles of the rocks enumerated above, and a considerable portion of vegetable mould. It has always a large pro-

portion of the latter in its composition in those lands which are very productive where the tea-shrub thrives best. In the gardens on the plains, at the foot of the hills, the soil is of a darker color, and contains a greater portion of vegetable matter, but generally it is either brownish or reddish-yellow. As a common practice, the Chinese prefer land which is moderately rich, provided other circumstances are favorable. For instance, some parts of Woo-e-shan are exceedingly sterile, and produce tea of very inferior quality. On the other hand, a hill in the same group, called Pa-ta-shan, produces the finest teas about Tsong-gan-hien. The earth on the hill-sides is moderately rich; that is, it contains a considerable portion of vegetable matter, mixed with the clay, sand, and particles of rock.

By far the greater portion of the tea in this part of the country is cultivated on the warm sloping sides of the hills, that grown in gardens on level land being more luxuriant; but these gardens are always a considerable height above the level of the river, and consequently are well drained. It will be observed, therefore, that the tea-plant on Woo-e-shan and the surrounding country grows under the following circumstances:

1. The soil is moderately rich, of a reddish color, well mixed with particles of the rocks of the district.

2. It is kept moist by the peculiar formation of the rocks and the water which is constantly oozing from their sides.

3. It is well drained, owing to the natural declivities of the hills, or, on the plains, by being a considerable height above the streams.

These appear to be the essential requisites, as regards soil, situation, and moisture. It was further ascertained that the tea-shrub will not succeed when planted in low, wet land; and this, doubtless, is one of the causes of the want of success in the culture of this plant.

On noting the climate of the tea districts of China, by commencing at the South, it will be seen that at Hong-kong, during the months of July and August—the hottest in the year—the maximum heat is 94° F. and the minimum 80°. The difference between the heat of day and night is usually about 10°. In winter, the thermometer sometimes sinks as low as the freezing point; but this occurrence is rare. Even in the midst of winter, when the sun shines, it is scarcely endurable for an American or European to walk out except in the shade. The air is so dry at this period that it is difficult for one to breathe. At other times, in winter, the wind blows cold and cutting from the north, and the houses cannot be kept comfortable without fires. In truth, at all seasons the climate is liable to sudden changes of temperature. Near Canton, some miles further north, snow sometime appears on the adjacent hills. The influence of the sea, however, in this part of the empire has a tendency to check the extremes both of heat and cold.

At Shanghae, some 600 miles north of Hong-kong, the extremes of heat and cold are much greater than those experienced in the provinces at the South. It appears from careful observations, kept at Shanghae, that, in July and August, the heat is at its maximum, the thermometer

sometimes indicating a temperature of 100° for several successive days. At the end of October, the mercury often sinks as low as the freezing point. December, January, and February are the coldest months in the year. In the winter of 1844–'45, the mercury fell as low as 26°. On the night of the 18th of December, and again on January the 4th, the instrument indicated 24°. But that winter was represented by the Chinamen as peculiarly mild, so much so that the usual supply of ice could not be procured. In ordinary years, the ponds and canals are frequently frozen several inches in thickness, and afford a plentiful supply. Therefore, in most years, it may safely be assumed that the thermometer sometimes stands at 12° or 20° below the freezing point. Snow frequently falls here in winter, but the sun is too powerful to allow it to lie long upon the ground. The months of April, May, and June are delightful; and although the sun is hot in the middle of the day, the air is agreeable and soft in the afternoon, and the evenings are cool and pleasant. During the autumnal months, the atmosphere is also cool and bracing, and the sky serene. The sun, for many days, and sometimes for weeks together, rises clear, runs his course, and sets in a cloudless sky. From the end of April to the middle of September, the prevailing winds blow from the south-west. During the remainder of the year, they are northerly and easterly, thus forming what are called the south-west and north-east *monsoons*. The last-named winds blow with great regularity in the south of China, but are more variable towards the north. In the latitude of Chusan and Shanghae, although the monsoons prevail, the wind not unfrequently comes from all quarters. In the end of the summer season, that is, from July to October, the country is frequently visited by dreadful gales, called *typhoons*, which commit most fearful ravages both at sea and on land.

The wet and dry seasons in the southern and tropical parts of China are more decided in their character than they are in the northern portions of the empire. At Hong-kong, and in the provinces of the South, the winter season, that is, from October to March, is generally dry, more particularly during November, December, and January. The wettest months in the year are those near the change of the monsoons, in May and June, and again in September, when the rains fall in torrents.

In the North, the rains also descend copiously at the change of the monsoons, more particularly in spring, at which time they are of the greatest utility to the newly-sown crops. Those parts of China, however, which are included within the temperate zone, cannot properly be said to have a wet and a dry season in the same sense as these terms are generally understood in the tropics. The winter months, which are dry at Hong-kong, are far from having the same character at Shanghae, where, for instance, there are frequently heavy falls of continued rain and snow. During the dry season, the sky for days and weeks together is without a cloud, and in the evening, vegetation is refreshed with copious dews.

In applying the foregoing data to the United States, with the view of comparing their soil and climate with those of China, it would

appear that the districts best adapted to the growth of the tea-plant would embrace the secondary or hilly tracts which lie between the Appalachian Mountains and the alluvial flat lands bordering on the tidal waters of Virginia, the Carolinas, Georgia, and Alabama, extending probably into Florida, and to the undulating portions of the temperate regions of Texas, Louisiana, Mississippi, Kentucky, and Tennessee. In traversing this belt of country, we recognize a series of eruptive and metamorphic rocks, silurian slate, tertiary and chalk formations, generally overlaid with soils composed of the fragments or particles of the same class of rocks existing beneath them, intermixed with variable proportions of humus or vegetable mould. Here, too, the climate for the most part is agreeable and favorable to health, the thermometer seldom ranging as low as 12°, and not higher than 100° F., in any portion of this tract; and in some parts snow is rarely seen. In the upper or more inland country, however, it sometimes falls to a depth of 5 or 10 inches, but the cold weather is not of very long continuance. Winter seldom commences before the beginning of December, and usually terminates in March. The spring is often rainy, although in many years fair weather prevails. The summer, though refreshed by enlivening breezes, is inconstant, being sometimes hot and dry, and at others accompanied by rains, with thunder and gusts of wind—the rains often so heavy as to deluge the fields. The autumn is usually fine and clear, except at the equinoctial period. The climate of a portion of Texas and Louisiana, however, differs considerably from that inland from the Atlantic and Gulf coasts, having comparatively little rain from March to October, though gusts of wind, with thunder, sometimes occur, attended by more or less rain. The winter is warm and mild, snow being seldom seen, except on or near the higher table-lands, or mountains, and the nights are cool and refreshing throughout the year.

IDENTIFICATION OF THE BLACK AND GREEN-TEA PLANT.

In the edition of Mr. Fortune's "Wanderings in China," published in 1846, are some observations upon the plants from which tea is made in different parts of the Celestial Empire; while acknowledging that the Canton plant, known to botanists as *Thea bohea*, was distinct from the more northern one, called *Thea viridis*, he endeavored to show that both black and green teas could be produced from either, and that the dissimilarity of appearance, so far as color was concerned, depended only upon manipulation. In proof of this, he remarked that the black-tea plant, found by him near Foo-chow-foo, at no great distance from the Bohea hills, seemed identical with the green-tea plant of Chekiang. These observations were met by the objection that, although he had been in many of the tea districts near the coast, yet he had not seen the more extensive ones inland which furnish the teas of commerce. Since that time, Mr. Fortune has visited both the green-tea country of Hwuy-chow and the black-tea districts about Woo-e-shan; and, during these long journeys, he verified the opinions previously formed. It is quite true that the Chinese rarely make the two kinds of tea in

the same district, but this is more for the sake of convenience and from custom than for any other reason. The workmen, too, generally make that kind of tea best with which they have had the most practice. Although this may generally be the case in the great tea districts, there are some exceptions. It is well known that the fine Moning districts near the Poyang Lake, which are constantly rising in importance on account of the superior character of their black teas, formerly produced nothing but green teas. At Canton, green and black teas are made from the Thea bohea at the pleasure of the manufacturer, or according to the demand.

CULTIVATION AND MANAGEMENT OF THE TEA PLANTATIONS.

In the black-tea districts of China, as in the green, large quantities of young plants are yearly raised from seeds. These seeds are gathered at maturity, in October, mixed immediately after, and packed in sand and earth, in which they are kept during the winter months. In this manner, they are preserved fresh until spring, when they are thickly sown in some corner of the farm, whence they are afterwards transplanted. Sometimes, they are sown in rows, where they are destined to grow, and consequently do not require to be removed. When about a year old, the plants are usually from nine inches to a foot in height, and are ready for transplanting. They are set in rows about four feet apart, in bunches, or hills, three or four feet asunder along the rows, with five or six plants to each bunch. In some cases, however, when the soil is poor, as in many parts of Woo-e-shan, they are planted very close in the rows, and appear like hedges when fully grown.

The young plantations are always made in the spring, and are well watered by the rains which fall at the change of the monsoon in April and May. The damp, moist weather, at this season, enables the plants to establish themselves in their new quarters, where they afterwards require but little care, except in keeping the ground free from weeds.

When the winters are very severe, the natives tie straw bands round the young tender shrubs to protect them from the cold, and to prevent them from cracking or bursting from frost or snow.

A tea plantation, when seen at a distance, looks like a little shrubbery of evergreens. As the traveller threads his way among the rocky scenery of Woo-e-shan, these plantations, which are constantly seen dotting the hill-sides, afford a pleasing contrast to the strange and often barren surface by their rich, dark-green leaves. When young, they are allowed to grow unmolested for two or three years, or until they are well established and producing strong and vigorous shoots. The practice of plucking the leaves is very prejudicial to this shrub, and the natives always take care that the plant shall be in a vigorous and healthy condition before this operation is commenced. Even when the plantations are in full bearing, they never take many leaves from the weaker plants, in order that their growth may not be checked. For, under the best mode of treatment, and on the most congenial

soil, they ultimately become stinted and unhealthy, and are never profitable when old. Hence, in well-managed tea-districts, the natives annually remove old plantations and supply their places with fresh ones.

The first crop of leaves is usually taken from the plants the third year. When under cultivation, they rarely attain a greater height than three or four feet. The length of time which a tea plantation will remain in full bearing depends, of course, upon a variety of circumstances, but, with the most careful treatment consistent with profit, the plants will not be of much value after ten or twelve years of age ; in fact, they often dry up, and the space must be replanted within that period.

MANIPULATION OF THE TEA LEAVES.

It is not the intention of the present paper to enter minutely into the subject of the manipulation of black and green teas. These methods, it may be stated, differ from one another in several particulars, which are quite sufficient to account for the difference of color. It would seem scarcely necessary to remark that both kinds of tea are gathered from the shrubs in the same way, and are made from the same description of leaves, namely, those which are young and recently formed.

Green Tea.—When the leaves intended to be made into green tea are brought in from the plantations, they are thinly spread out on flat bamboo trays, in order that the superfluous moisture may be evaporated. They remain only for a short time exposed in this manner, say, generally, from one to two hours. This, however, depends much upon the state of the weather. In the meantime, the roasting pans have been heated with a brisk wood fire. A portion of the leaves are then thrown into each pan, and rapidly moved about and shaken up with both hands. They are immediately affected by the heat, becoming quite flaccid and moist, and giving out a considerable vapor. In this state, they remain four or five minutes, when they are quickly drawn out and placed on the rolling table.

Next commences the rolling process. Several men, stationed at the table, divide the leaves among them. Each takes as many as he can press with his hands, and makes them up in the form of a ball, which is rolled upon the rattan-worked table, and in this manner becomes greatly compressed, the object being to get rid of a portion of the sap, or moisture, and at the same time to twist the leaves. These balls are frequently shaken out and passed from hand to hand until they reach the head workman, who carefully examines them to see if they have acquired the requisite twist. When he is satisfied of this, the leaves are removed from the rolling table and shaken out upon flat trays, until the remaining balls have undergone the same process. In no case are they allowed to lie long in this condition, and sometimes they are removed at once to the roasting-pan.

Having been thrown again into the pan, a slow and steady charcoal fire is kept up, and the leaves are put into rapid motion by the

hands of the operators. Sometimes they are thrown upon the rattan-table and rolled a second time. In from an hour to an hour and a half the leaves become well dried, and their color "fixed;" that is, there is no danger of their turning black. They are now of a dullish green, but afterwards become brighter. This process, it is to be understood, does not apply to teas which are artificially colored. As the most particular part of the operation is now finished, the tea is put aside until a larger quantity has been made.

The second part of the process consists in winnowing and passing the tea through sieves of different sizes, in order to get rid of the dust and other impurities, and to divide the tea into classes, known by the names of "twankay," "hyson skin," "hyson," "young hyson," "gunpowder," &c. During this operation, it is "refired," the coarse kinds once, and the finer sorts three or four times. At this stage the color has become more decided, and the leaves of the superior kinds are of a dull bluish-green.

Thus it will be observed, with reference to green tea, that, *first*, the leaves are roasted almost immediately after they are gathered; *second*, that they are quickly dried off after the process of rolling.

Black Tea.—When the leaves designed to be manufactured into black tea are brought in from the plantation, they are spread upon large bamboo mats or trays, *and are allowed to lie in this state for a considerable time.* If brought in at night, they remain upon the trays until the next morning. They are next gathered up by the workmen with both hands and thrown into the air, in order to separate as they fall. In this manner, they are tossed about and slightly beaten or patted with the hands until they become flaccid and soft, when they are cast into heaps and allowed to remain in this condition for an hour, or, perhaps, a little longer. When examined, at the expiration of this period, they appear to have undergone a slight change in color, are soft and moist, and emit a fragrant smell.

The next part of the process is exactly the same as in the manipulation of green tea. The leaves are thrown into an iron pan, when they are roasted for about five minutes, and rolled upon the rattan table.

After being rolled, the leaves are thinly shaken out on sieves, and exposed to the air out of doors. For this purpose, a frame-work made of bamboo is seen in front of cottages among the tea hills. In this condition, the leaves are allowed to remain for about three hours, while the workmen are employed in going over the sieves in rotation, turning the leaves and separating them from each other. A fine, dry day, when the sun is not too bright, seems to be preferred for this part of the operation.

The leaves having now lost a large portion of their moisture, and become considerably reduced in size, are removed into the factory, where they are again put into the roasting-pan for three or four minutes, and taken out and rolled as before. A charcoal fire is now got ready, over which is placed a tubular basket, narrow in the middle and wide at each end. A sieve is dropped into this tube, on which the leaves are shaken to a thickness of about an inch. After five or six minutes of careful watching, the leaves are removed from the fire

and rolled a third time. As the balls come from the hands of the roller, they are placed in a heap, until the whole batch has been rolled. They are again shaken on the sieves, and set over the fire a little while longer. Sometimes the last-named operation, namely, heating and rolling, is repeated a fourth time, or until the leaves have assumed a dark color. When the whole batch has been gone over in this manner, it is thickly placed in the baskets, which are once more set over the charcoal fire. The operator now makes a hole with his hand through the centre of the leaves, in order to allow vent to any smoke or vapor which may rise from the charcoal, as well as to admit the heat, and then covers the whole with a flat basket. Previous to this, the heat has been greatly reduced by covering up the fire. The tea now remains over this slow fire until it is quite dry, being carefully watched, however, by the manufacturer, who every now and then stirs it up with his hands so that the whole mass may be equally exposed to the heat. The black color is now fairly produced, but afterwards improves. The after processes, such as sifting, picking, and "refiring," are carried on at the convenience of the workmen.

Thus it will be seen, with reference to the leaves which are to be converted into black tea, *First*, that they are allowed to lie for some time spread out in the factory, and before they are roasted. *Second*, that they are tossed about until they become flaccid and soft, and then left in heaps, and that this also is done before they are roasted. *Third*, that after being roasted for a few minutes and rolled, they are exposed in a soft and moist state for several hours to the air. *Fourth*, that they are at last dried slowly over charcoal fires.

The differences in the manufacture of black and green teas are therefore most marked, which will fully account for the variations in color, as well as for the effect produced on some constitutions by green tea.

MODES OF PACKING AND TRANSPORTATION OF THE TEA.

The tea-farms in China are generally of small extent, no single one probably producing more than 600 chests of tea. What are called "chops," or parcels, are not made up by the small farmers, but in the following manner: A tea merchant, for instance, from Tsong-gan or Tsin-tsun, either goes himself, or sends his agents, to all the small towns, villages, and temples in the district, to purchase teas from the priests and growers. When the teas so purchased are taken to his house, they are mixed together, keeping those of different qualities as much as possible apart. By this means a chop of 620 or 630 chests is made, and all the tea of this chop is of the same description or class; sometimes a chop is divided into two packings, consisting generally of 300 chests each. If it were not managed in this way, there would be several kinds of tea in one chop. The large merchant in whose hands it now is, has to refire it and pack it for the foreign market. When the chests are packed, the name of the chop is written upon each. Year after year, the same chops, or rather those having the same names, find their way into the hands of the

foreign merchant. Some, consequently, have a better reputation, and command a higher price than others. It does not follow, however, that the chop of this year, bought from the same man and bearing the same name as a good one of last year, will be of equal quality; for it is by no means unusual for the merchant who prepares and packs the tea to leave his chests unmarked until they are bought by the man who takes them to the port of exportation. This man, knowing the chop names most in request, can probably find a good one to put upon his boxes; at all events, he will take care not to put upon them a name which is not in good repute.

A chop of tea having been purchased in the neighborhood of Woo-e-shan, for instance, by one of these merchants, a number of coolies are engaged to carry the chests northward, across the Bohea Mountains, on their way to Canton or Shanghae, the ports of exportation, by the way of Tsong-gan-hein and Hokow, or rather to the small town of Yuen-shan, a few miles from Hokow, to which it is sent by boat. If the tea is of a common kind, each coolie carries two chests slung over his shoulders, on his favorite bamboo, as indicated in the following cut:

Mode of Carrying Common Tea.

Whenever he rests, either on the road or at an inn, the chests are set down upon the ground, which is often wet and dirty, and consequently they are liable to get soiled. The finest teas, however, to preserve them from injury, are never allowed to touch the ground while on their journey, but are carried on the shoulders of the coolies in the following manner: Two bamboos, each about 7 feet long, have their ends lashed firmly to the chest, one on each side. The other ends are brought together so as to form a triangle. By this means a man can carry the chest upon his shoulders, with his head between the bamboos in the centre of the triangle. A small piece of wood is lashed under the chest to give it an easy seat. The accompanying sketch will give a better idea of this curious mode of carrying tea than any description.

When the coolie who bears his burden in this way wishes to rest, he places the ends of the bamboos upon the ground and raises them to a perpendicular. The whole weight now rests upon the ground,

Mode of Carrying Finest Tea.

and can be kept in this position without much exertion. This is very convenient in coming up the steep passes among the mountains, for in some of them, the coolies can only proceed a few yards at a time without resting, and if they had not a contrivance of this description, the loads would have to be frequently put down on the ground. When stopping at inns or tea shops for refreshments, the chests carried in this way are set up against the wall, and rest upon the ends of the bamboos.

Hokow is a large and flourishing town, situated on the banks of the river King-keang, abounding in tea hongs, which are resorted to by merchants from all parts of China. Many of these men make their purchases here without going further, while others cross the Bohea Mountains to Tsong-gan-hien. The teas, having arrived at Hokow, are put into large flat-bottomed boats, and proceed on their journey either to Canton or Shanghae. If intended for the Canton market, they are conveyed down the river in a westerly direction, towards the Poyang Lake. They are conducted to the towns of Nan-chang-foo and Kan-chew-foo, and then suffer many transhipments on their way to the pass of Ta-moey-ling, in that part of the same chain of mountains which divides Kiang-see from Quan-tung. At this pass, the teas are again carried by porters, the journey requiring a day, when they are reshipped in large vessels, which convey them to Canton. The time occupied in the entire transport from the Bohea country to Canton is about six weeks or two months.

If intended for the Shanghae market, the tea boats proceed up the river King-keang in an easterly direction to the town of Yuk-shan. This stream runs very rapidly, and, upon an average, at least four

days are required for this part of the journey. In coming down the river, the same distance is easily accomplished in a day. When the tea chests arrive at Yuk-shan, they are taken from the boats to a warehouse. An engagement is then entered into with coolies, who carry them across the country in an easterly direction to Chang-shan, in the same manner as they were brought from Tsong-gan-hein to Hokow. The town of Yuk-shan, it will be observed, is at the head of a river which flows west to the Poyang Lake, while that of Chang-shan is situated on an important river which falls into the bay of Hang-chow on the east. Travellers in chairs accomplish the distance easily in a day, but coolies laden with tea chests require two or three days. When the teas arrive at Chang-shan they are put into boats and conveyed down the river to Hang-chow-foo, occupying five or six days. At Hang-chow-foo the chests are transhipped from the river boats to those which ply upon the canals, and in the latter are taken on to Shanghae, which occupies about five days.

In retracing the route which the black teas have to travel on their way from Woo-e-shan to Shanghae, the distance travelled and time occupied will stand thus:

ROUTES.	English miles.	Days.
Tsong-gan-hein to Hokow	$93\frac{1}{3}$	6
Hokow to Yuk-shan	60	4
Yuk-shan to Chang-shan	$33\frac{1}{3}$	3
Chang-shan to Hang-chow-foo	$266\frac{2}{3}$	6
Hang-chow-foo to Shanghae	$166\frac{2}{3}$	5
Say	620	24

In calculating the time, it will be necessary to allow about four days consumed in changing boats, for bad weather, &c. This will make the whole journey occupy twenty-eight days, which is about the average time.

DYEING GREEN TEAS.

As many persons in this country, as well as in Europe, have a peculiar taste for "colored" green teas, the following account of the coloring process, given by Mr. Fortune, as practised in the Hwuy-chow green-tea district upon those teas which are destined for the foreign markets, may not prove uninteresting to the American reader. The following is extracted *verbatim* from Mr. Fortune's Note Book:

"The superintendent of the workmen managed the coloring part of the process himself. Having procured a portion of Prussian blue, he threw it into a porcelain bowl, not unlike a chemist's mortar, and crushed it into a very fine powder. At the same time, a quantity of gypsum was produced and burned in the charcoal fires which were then roasting the teas. The object of this was to soften it in order

that it might be readily pounded into a very fine powder, in the same manner as the Prussian blue had been. The gypsum, having been taken out of the fire after a certain time had elapsed, readily crumbled down, and was reduced to powder in the mortar. These two substances, having been thus prepared, were then mixed together in the proportion of four parts of gypsum to three parts of Prussian blue, and formed a light-blue powder, which was then ready for use.

"This coloring matter was applied to the teas during the last process of roasting. About five minutes before the tea was removed from the pans—the time being regulated by the burning of a joss-stick—the superintendent took a small porcelain spoon, and with it he scattered a portion of the coloring matter over the leaves in each pan. The workmen then turned the leaves rapidly round with both hands, in order that the color might be equally diffused.

"During this part of the operation the hands of the workmen were quite blue. I could not help thinking that if any green-tea drinkers had been present during the operation their taste would have been corrected, and, I may be allowed to add, improved. It seems perfectly ridiculous that a civilized people should prefer these dyed teas to those of a natural green. No wonder that the Chinese consider the natives of the West to be a race of 'barbarians.'

"One day an English gentleman in Shanghae, being in conversation with some Chinese from the green-tea country, asked them what reasons they had for dyeing the tea, and whether it would not be better without undergoing this process. They acknowledged that tea was much better when prepared without having any such ingredients mixed with it, and that they never drank dyed teas themselves, but justly remarked that, as foreigners seemed to prefer having a mixture of Prussian blue and gypsum with their tea, to make it look uniform and pretty, and as these ingredients were cheap enough, the Chinese had no objection to supply them, especially as such teas always fetched a higher price!

"I took some trouble to ascertain precisely the quantity of coloring matter used in the process of dyeing green teas, not certainly with the view of assisting others, either at home or abroad, in the art of coloring, but simply to show green-tea drinkers in England, and more particularly in the United States of America, what quantity of Prussian blue and gypsum they imbibe in the course of one year. To $14\frac{1}{2}$ pounds of tea were applied 8 mace $2\frac{1}{2}$ candareens of coloring matter, or rather more than an ounce. In every hundred pounds of colored green tea consumed in England or America, the consumer actually drinks more than half a pound of Prussian blue and gypsum. And yet, tell the drinkers of this colored tea that the Chinese eat cats, dogs, and rats, and they will hold up their hands in amazement, and pity the poor Celestials!

"Two kinds of Prussian blue are used by the tea-manufacturers—one is the kind commonly met with, the other I have seen only in the north of China. It is less heavy than common Prussian blue, of a bright pale tint, and very beautiful. Tumeric-root is frequently employed in Canton, but I did not observe it in use in Hwuy-chow."

From the foregoing it would seem that we have a soil and climate possessing the conditions necessary for the production of the tea-plant in a large portion of our territory, and that it only requires enterprise, capital, and intelligence to bring this branch of industry into successful competition with the Celestials. To meet the objection often raised against the profitable culture of tea in this country, of the very low wages in China as compared with our own, it may be stated that, with improved machinery and other appliances for manipulating and preparing the article, which would result from American skill, with the aid of a few Chinamen, at first; our facilities for transportation to a ready market, and the robust, well-fed laborers, there can be little doubt that we can out-rival, at least for local consumption, the primitive utensils, tedious manipulations, the want of railroads, canals, steam navigation, and even of common roads, and consequent expensive transport of the enfeebled and poorly-fed Asiatics, to say nothing of extra packing, transit and export duties, port charges, cost of putting on ship-board, freight, insurance, interest on capital invested, cartage, storage, commissions, profits of the importer and venders, as well as the cost of transportation to the place of consumption in the United States.

SORGHUM CANES.

REPORT OF THE UNITED STATES AGRICULTURAL SOCIETY.

Conformably to the resolutions adopted by the United States Agricultural Society, held at the city of Washington in January, 1857, the committee appointed to investigate and experiment upon the *Sorgho sucré*, or Chinese Sugar-cane, with the view of determining its value for the purposes of syrup and sugar-making, soiling cattle, use of the seed for feeding stock, for bread-making, and for the manufacture of paper, and alcoholic liquors, beg leave to report as follows :

Agreeably to the requirements, there was imported from France sufficient sorgho seed to plant 100 acres of land. This seed was placed in the hands of a number of individuals in different sections of the country, who cultivated it under various conditions of soil, climate, &c. From the results of their experiments, in ninety localities, between New Brunswick, in the British dominions, and Mexico on the one hand, and between Florida and Washington Territory on the other ; though contradictory or conflicting with each other in some instances, the committee arrived at the following conclusions :

1. The soil and geographical range of the Chinese Sugar-cane correspond nearly with those of Indian corn, and it thrives with great luxuriance in rich bottom lands, or in moist loamy soils, well manured. It will also produce a fair crop on dry, sandy, or gravelly

soils too poor to give a remunerative crop of other plants. On the latter class of soils, however, it proved more profitable to the cultivator where there had been applied a moderate quantity of bone-dust, wood ashes, poudrette, phosphated guano, gypsum, or superphosphate of lime.

2. This plant endures cold much better than corn, and resists without injury the ordinary autumnal frosts. It will also withstand excessive drought. In favorable seasons, when planted early in May, it will ripen its seeds in September, if the soil be dry and warm, in many parts of the extreme Northern and New England States, and in October in the Middle and Southern States, when planted as late as the 20th of June. At the extreme South, it may be planted successively from January into July.

3. The cost and culture of this plant does not differ essentially from that of Indian corn. The seeds require to be planted at different distances apart, according to the strength of the soil. On light, moderately-rich land, it succeeded best when sown in rows or drills 3 feet apart, with the plants a foot asunder along the drills, or in hills with a corresponding number of stalks to each ; but on richer land, it has been found preferable to plant the hills 4 or 5 feet asunder. If cultivated exclusively for soiling or dry fodder, the seed may be sown broad-cast or in drills, and treated in the same manner as Indian corn when grown for that use.

4. The height of the plant when fully grown varies from 6 to 18 feet, according to the locality and the condition of the soil; the stalks ranging from half an inch to two inches in diameter. The weight of the entire crop to an acre, when green, varies from 10 to 40 tons. The amount of seed to the acre is reported to range from 15 to 60 bushels.

5. During the earlier stages of the growth of this plant, say for the first six or eight weeks, it makes but little progress, except in penetrating the ground with its roots, which occasioned so great disappointment in some cultivators that they exterminated it from their fields, and replanted for other crops. From the natural tendency of the genus to which it belongs to sport or run into varieties, many persons have come to wrong conclusions with a belief that the seed was impure or mixed. The period of growth varied from ninety to one hundred and twenty days; the seeds often ripen unequally in the same field.

6. The yield of juice in weight of well-trimmed stalks was about 50 per cent. The number of gallons of juice required to make a gallon of syrup varied from 5 to 10, according to the locality, the nature of the soil on which it was produced, and the succulent condition or maturity of the canes. In the Province of New Brunswick it required 10 to 1 ; in the rich bottom lands of Indiana and Illinois about 7 to 1 ; and in light lands in Maryland and Virginia, 5 gallons to 1 of syrup. The yield of syrup per acre varied from 150 to 400 gallons. The amount of pure alcohol produced by the juice ranged from 5 to 9 per cent. In cases where the plant was well matured and grew upon a warm, light soil, the juice yielded from 13 to 16

per cent. of dry saccharine matter; from 9 to 11 per cent. of which was well-defined crystallized cane-sugar, and the remainder, uncrystallizable matter, or glucose; but that taken from stalks obtained on rich low-lands, luxuriant in their growth, yielded considerably less.

7. A palatable bread was made from the flour ground from the seeds of this plant, of a pinkish color, caused by the remnants of the pellicles, or hulls, of the seeds.

8. By accounts from all parts of the country, this plant is universally admitted to be a wholesome, nutritious, and economical food for animals; all parts of it being greedily devoured, in a green or dried state, by horses, cattle, sheep, poultry, and swine, without injurious effects; the two latter fattening upon it equally as well as upon corn.

9. Paper of various qualities has been manufactured from the fibrous parts of the stalk, some of which appear to be peculiarly fitted for special use, such as bank notes, wrapping paper, &c.

From the above summary, the committee are of opinion that the Sorgho sucré possesses qualities which commend it to the especial attention of the agriculturists of all parts of the country, as the preceding facts have demonstrated that it is well suited to our national economy, and supplies what has been long a great desideratum.

All of which is respectfully submitted.

D. JAY BROWNE,
Chairman.

ON THE IDENTITY AND HYBRIDITY OF THE CHINESE AND AFRICAN SUGAR-CANES.

[Condensed from the Proceedings of the Boston Society of Natural History.]

The subject of the hybridity of plants has lately received careful attention. The question has arisen, whether they would mix by cross-fecundation so freely, and exchange peculiarities when they are of different species, as they do in varieties of the same species. Does not this hybridity point to identity? Attention is called to grasses which grow broad-cast in our fields; they do not hybridize naturally, nor so perfectly as to become diversified in inextricable series of graduated forms. The Poas, Panicums, and Festucas, which abound in our meadows, do not interchange their specific peculiarities, but grow side by side, and maintain their identity. Yet the different species and varieties of Sorghum are no sooner cultivated in proximity to each other—the Chinese Sugar-cane, Broom corn, and Dourah corn, for instance—than the three amalgamate and produce an offspring combining the characteristics of all. Again, from a series of interesting experiments recently made by Mr. Charles Naudin, on the cultivated pumpkins and squashes, he arrived at the conclusion, after particularly examining those changes which artificial impregnation will produce, that nearly all of those grown in our gardens may be referred to a single species. It has often been asserted that cucurbitaceous plants should not be cultivated together, as they would injure each other.

This gives rise to the question, whether a fruit of one and the same season can acquire by cross-fecundation the peculiarities of another fruit, or whether it is necessary that the seed produced from such cross should be cultivated to result in any change. The former, it appears, has proved to be the case. The influence of the pollen on a fruit of the same year is such as to communicate to it the characteristics of the plant furnishing the pollen.

The sports and varieties of Indian corn have a strong bearing upon the specific identity of the varieties of Sorghum under consideration. Though some botanists have made species out of the varieties of corn, it is generally believed that these are all the results of the cultivation of a single species. One peculiarity, in particular, in this respect, may here be mentioned: a corn plant has been found growing apparently wild, with the grains entirely covered by glumes, or husks, which project beyond it. It is also known that, by continued cultivation, these glumes disappear, or become so abbreviated as to allow the grains to be uncovered, as in our common varieties. A similar difference is to be seen in the various forms of Sorghum. The Dourah exhibits this abbreviation of glume and prominence of grain the most, and is the variety believed to have been the longest under cultivation. Thirty-one specimens were laid before the Society, grown in this country, the seeds of which came originally from widely-separated localities. The differences they exhibited were in the color, shape, and hairiness of the glumes; the color, shape, and prominence of the grains beyond the glumes, and the open or compact growth of the panicles. Had these differences of shape been attended simply by a difference in color, and that color invariably accompanied by the same hairiness and projection of seeds, there would have been strong ground to establish specific distinctions. But such was not the case. The specimens placed side by side exhibited a complete graduation between the extremes of the series. Those which varied most in shape were similar in color; and those which differed in color were identical in shape. The hairiness and degree of projection in the grain were co-existent with the extremes of shape and color. There were four varieties of especial interest. The seeds of Chinese Sugar-cane, planted between those of Broom corn and Dourah, produced plants apparently partaking equally of the characteristics of those on each side. The eighteen varieties of African Sugar-cane, (imphee,) thought to be so distinct that different native names had been given them, presented every intermediate form. Some glumes were nearly white, others speckled with brown and black; and some again were all brown, while others were all black. Some had ovate pointed glumes of various hues; others had obtuse glumes, with a broad scarious point, or rounded glumes, with no point, through the same series of color. The grains were either inclosed or exserted through the whole series, irrespective of color or form. Some of the varieties exhibited a peculiar appearance from a persistence and prominence of the sterile spikelets, being in some instances scarcely visible, or not appearing at all. As color and pubescence are among the least reliable of botanical characters, they should have but little weight in determining the distinction of plants so closely allied.

With the preceding facts before us, it is to be inferred that the Chinese and African Sugar-canes, Broom corn, and Dourah, are only varieties of a primitive species, the *Andropogon sorghum*, of authors; or, allowing the genus Sorghum to stand, *Sorghum vulgare*, the establishment of which will answer many of the questions that have been asked regarding the economical value of these plants. If they be of one species, they would, of course, hybridize, and exchange whatever properties they possess. The saccharine secretions of one variety will be diminished by cross-fecundation with another not producing an equal amount; and the saccharine qualities peculiar to one may be lost by planting in a soil or climate differing from that which has brought them forth in unusual quantity. If their cultivation as a forage crop and a syrup and sugar-producing plant shall prove profitable, the use of the grain in the form of flour, as well as food for stock, may considerably diminish the cost of production.

D. J. B.

CHEMICAL RESEARCHES ON THE CHINESE AND AFRICAN SUGAR-CANES.

BY CHARLES T. JACKSON, M. D., OF BOSTON, MASSACHUSETTS.

On the 16th of September, 1857, I obtained from Braintree, Massachusetts, a quantity of unripe canes (No. 1) of Sorghum, (Chinese variety,) just as they were about to flower. Two pounds of these canes gave, in a screw-press, 10 ounces of juice, or $31\frac{1}{4}$ per cent. I observed a considerable deposit of white starch from the juice of these plants, and on collecting it and applying the usual test of tincture of iodine, it was converted into the rich blue iodide of starch. I was able to determine by microscopic research the kind of starch to which this belongs. It was found identical with that from young Indian corn (Zea mays.) Last year, while making my researches as published in the Patent Office Report of 1856, I discovered the presence of starch in the unripe plant and in its expressed juice. This year, these results are fully confirmed. Having filtered the juice, to remove, as far as practicable, all the starch, globules, and other mechanical sediments, I took its specific gravity, and found it to be 1.044, from which it was calculated to contain 11 per cent. of saccharine matter. By direct experiment, I obtained $10\frac{1}{2}$ per cent. of dense syrup, made as dry as possible in vacuo, over sulphuric acid. It was found that this syrup would give no crystals of sugar. On redissolving it in alcohol, a considerable quantity of gum, or dextrine, was left, and the alcoholic solution, slowly evaporated in a desiccated atmosphere, gave a mass of scopiform acicular crystals of grape or fruit-sugar, without any crystal of cane-sugar. These experiments were repeated on another portion of the juice, with a variation of the methods of operating, and the same results were again obtained.

No. 2. I procured from Newton Centre some specimens of Sorghum

plants and juice on the 18th of September, at a time when they were just flowering, and found that they yield only grape-sugar in this stage of their growth.

The juice of these canes, after it is filtered, has a specific gravity of 1.036, and by calculation, it should contain 9 per cent. of saccharine matter. I obtained, however, only 7.8 per cent. from one portion, and 9.36 per cent. from another. The juice of these unripe plants deposits much starch, and contains, also, dextrine or gum.

Two thousand grains of the juice evaporated in vacuo gave 186 grains of extract, or 9.36 per cent; but, on solution of the saccharine matter, in hot alcohol, a large quantity of dextrine and starch remains behind.

October 7th. I again obtained from Newton Centre a quantity of the juice of the canes then grinding, which had just passed through the stage of flowering, the young seeds having begun to form. The juice of these plants, after filtration, had a specific gravity of 1.0492 at 55° F.; hence, by calculation, it should contain 12 per cent. of saccharine matter.

An imperial pint of this juice, weighing 1 pound 4¾ ounces, operated upon after Wray's patented method, gave 2¾ ounces of thick, dark molasses, *but no crystals of sugar.*

Two hundred grains of the filtered juice, treated with lime, enough to neutralize the acids, boiled and filtered to remove the feculent matters, and the clear juice then evaporated to thick syrup, in warm sand, *in vacuo*, gave 202 grains of extract, or 10½ per cent. This acted upon by hot alcohol, which dissolved the saccharine matters, left starch, and gum, or dextrine, and the alcoholic solution evaporated in a desiccated atmosphere, gave a solid mass of fibrous, or acicular crystals of pure grape-sugar, without any cane-sugar discoverable under the microscope. Sixteen fluid ounces of the clarified juice were set with a little yeast to ferment, and were then distilled, and the returns were fermented over again, and distilled a second time. The result was that the absolute alcohol obtained from the juice was 4.9 per cent.

By experiment it was found that it is necessary to defecate the juice of the Sorghum before setting it to ferment, otherwise the viscous fermentation sets in, and converts all the sugar into lactic acid and *mannite.* Hence, when either vinegar, alcohol, or wine, is to be made from the juice of this plant, it must first be clarified, or defecated by lime and heat, and then filtered.

When this is done, the juice is readily made to undergo the vinous fermentation by the addition of a little brewer's yeast, and afterwards the returns will serve for yeast to any quantity of the juice that it may be desired to ferment.

I mention this, because I know that many persons, unaware of the above-named facts, have lost the Sorghum juice they had endeavored to ferment both for vinegar and wine.

At the proper temperature, the Sorghum juice will undergo the vinous fermentation in from three to five days.

November 6th. I received from the Patent Office a series of samples

of the Sorghum saccharatum, all of which came to hand in good order. They were numbered as given below.

No. 3, (African variety.) Juice was expressed from one pound of the stalks by means of a screw-press, and 5¼ ounces obtained. After filtration through paper, it had a specific gravity equal to 1.065, from which it was estimated to contain 16 per cent. of saccharine matter. By experiment, I obtained 15.9 per cent. The sugar crystallized beautifully in the course of two or three days, and was found to be wholly of the cane-sugar type, the crystals being rhombic prisms, six-sided prisms, and the other usual secondaries of the primary rhombic prism.

A little starch was found in the bottom of the glass which received the expressed juice.

No. 6, (African.) One pound of the stalks gave 7¾ ounces of juice, which, after filtration, had a specific gravity of 1.0476, and hence was calculated to contain 12 per cent. of saccharine matter. It yielded by experiment 12.6 per cent. of thick molasses, which does not crystallize, and contains much gummy matter. The experiment was repeated on another portion of the juice, evaporation being effected *in vacuo*, but the same results were obtained. Hence, there is no doubt that this plant, when unripe, contains, like the first-named specimen, only grape-sugar.

No. 7, (African,) gave, on pressure of a pound of stalk, 5½ ounces of juice, which, when filtered, had a specific gravity of 1.06, and should contain by estimation 15 per cent. of saccharine matter.

By experiment it was found to yield 14.3 per cent. of thick syrup, which, in a few days, struck into crystals of the cane-sugar type, and but very little molasses remained among the sugar crystals.

No. 9, (Chinese.) A ripe plant. One pound of this specimen yielded in the press 8½ ounces of juice. Some starch granules were found, as a sediment, in the receiving vessel, but not so much as usual. The filtered juice had a specific gravity of 1.062, from which it was estimated to contain 15½ per cent. of saccharine matter. It yielded, however, 16.6 per cent. of thick syrup, which crystallized almost wholly into cane-sugar, the whole mass becoming solid with crystals. These were examined by the microscope, and their angles measured, so as to be sure of their type.

Two thousand grains of the above-named expressed and filtered juice, limed, defecated and filtered, on evaporation *in vacuo*, gave a thick syrup, which being treated with hot alcohol, to dissolve out the sugar from the gum, gave, on slow evaporation of the alcohol in dried air, 180 grains of crystallized cane-sugar, while 17.4 grains of gum (dextrine) and starchy matter remained undissolved with the salts and lime. On combustion of the organic matters, there remained, of salts, 3 grains; which consisted of—

Phosphate of lime	0.11
Carbonate of lime	1.35
Salts, (phosphate of potash,)	0.11
	3.00

The lime separated as a carbonate was evidently that which was introduced in defecating the juice. The other salts belong to it as constituents of the sap.

No. 11, (African.) One pound of the stalks gave 6 ounces of juice, which, after filtration, had a specific gravity of 1.0505, hence should contain 13 per cent. of saccharine matter. On experimental trial, it was found to yield 14.6 per cent. of thick syrup, which crystallizes perfectly into cane-sugar, leaving but little molasses among the crystals.

From these researches, I am fully satisfied that both the Chinese and the African varieties of Sorghum will produce sugar of the cane type perfectly and abundantly, whenever the canes will ripen their seeds. The Chinese variety is certainly preferable for this country, particularly for the Middle and Northern sections of the United States. During the past summer, these plants have not had a fair chance, since it has been very cold, and unsuited to the development of the crop.

I trust the farmers of the Northern and North-western States will not be discouraged, but will try again, when they may not only make a syrup, or molasses, but also good crystallized sugar. If vacuum apparatus could be applied to this manufacture, it would be far more sure to succeed, and perhaps in the operations of a large farmer, it may not prove an unprofitable investment to set up vacuum pans on his estate expressly for sugar-boiling. If this cannot be done, we have only to caution the experimenters against burning the syrup, and to ask them to wait at least a week before they expect to see their sugar granulate.

The results of experiments on the production of alcohol are given in the annexed table, and the processes being all exactly like the one detailed in the first part of this Report, I refrain from repeating them.

Summary of results of the preceding analyses.

NO.	VARIETIES.	LOCALITIES.	Specific gravity.	Calculated saccharine matter per cent.	Obtained result per cent. saccharine matter	Character of sugar.	Stage of growth of plant.	Alcohol produced per cent. on the juice.	Remarks.
1	Chinese	Braintree, Mass	1.0440	11	$10\frac{1}{2}$	Grape only	Not yet flowered.	5.5	Taken September 16. Yields much starch.
2	Chinese	Newton Centre, Mass	1.0360	9	9.36	Grape only	Just flowering	4.9	Taken September 18. Yields much starch.
3	African	Washington, D. C	1.0650	16	15.9	Cane well crystallized.	Nearly ripe	8.4	Some starch falls.
6	African	Washington, D.C	1.0476	12	12.6	Grape	Early milk	6.5	Little starch falls.
7	African	Washington, D.C	1.0600	15	14.3	Cane well crystallized	Nearly ripe	8.0	No starch.
9	Chinese	Washington, D.C	1.0620	$15\frac{1}{2}$	16.6	Cane nearly all crystallized.	Quite ripe	9.1	No starch.
11	African	Washington, D. C	1.0505	13	14.6	Cane well crystallized.	Nearly ripe	8.0	No starch.

MANUFACTURE OF SUGAR AND SYRUP FROM THE JUICE.

Omitting, as of no immediate practical value to the manufacturer, the more refined processes, which were employed in determining the amount of saccharine matter in the juice of this plant, I now describe a cheap and economical method of syrup and sugar-making, which may be used by the farmer.

In the first place, it is necessary to filter the juice of the plant, as it comes from the mill, in order to remove the cellulose and fibrous matters, and the starch, all of which are present in it when expressed. A bag filter, or one made of a blanket placed in a basket, will answer this purpose. Next, we have to add a sufficiency of milk of lime (that is, lime slaked and mixed with water) to the juice, to render it slightly alkaline, as shown by its changing tumeric paper to a brown color, or reddened litmus paper to a blue. A small excess of lime is not injurious. After this addition, the juice should be boiled, say for fifteen minutes. A thick greenish scum rapidly collects on the surface, which is to be removed by a skimmer, and then the liquid should again be filtered. It will be of a pale straw color, and ready for evaporation. It may now be boiled down quite rapidly to about half its original bulk, after which the fire must be kept low, the evaporation to be carried on with great caution, and the syrup constantly stirred to prevent it from burning at the bottom of the kettle or evaporating pan. Portions of the syrup are to be taken out, from time to time, and allowed to cool, to see if it is dense enough to crystallize. It should be about as dense as sugar-house molasses, or tar. When it has reached this condition, it may be withdrawn from the evaporating vessel, and be placed in tubs or casks to granulate. Crystals of sugar will begin to form generally in three or four days, and sometimes nearly the whole mass will granulate, leaving but little molasses to be drained. After it has solidified, it may be scooped out into conical bags, made of coarse open cloth, or of canvas, which are to be hung over the receivers of molasses; and the drainage being much aided by warmth, it will be useful to keep the temperature of the room at 80° or 90° F. After some days, the sugar may be removed from the bags, and will be found to be a good brown sugar. It may now be refined by dissolving it in hot water, adding to the solution some whites of eggs, (say one egg for 100 pounds of sugar,) mixed with cold water, after which the temperature is to be raised to boiling, and the syrup should be allowed to remain at that heat for half an hour. Then skim and filter, to remove the coagulated albumen, and the impurities it has extracted from the sugar.

By means of bone-black, such as is prepared for sugar refiners, the sugar may be decolored by adding an ounce to each gallon of the saccharine solution, and boiling the whole together. Then filter, and you will obtain a nearly colorless syrup. Evaporate this, as before directed, briskly, to half its bulk, and then slowly until dense enough to crystallize, leaving the syrup, as before, in tubs, or pans, to granulate.

This sugar will be of a very light-brown color, and may now be clayed, or whitened, by the usual method—that is, by putting it into cones and pouring a saturated solution of white sugar upon it, so as to displace the molasses, which will drop from the apex of the inverted cone. The sugar is now refined as loaf sugar.

The methods here described are the common and cheap ones, such as any farmer can employ. It may be advantageous, when operations of considerable extent are contemplated, to arrange a regular system of shallow evaporating pans for the concentration of the syrup, similar to those now used in Vermont for making maple sugar.

It is evident that no ordinary methods can compete with those of a regular sugar refinery, where vacuum pans are employed, and evaporation is consequently carried on at a very low temperature. If the planter should raise sufficiently large crops to warrant the expense of such an apparatus on his farm, he would not fail to manufacture larger quantities of sugar, and to operate with perfect success in sugar-making; but this can be done only in the Southern, Middle, or Western States, where extensive farming is common. Those who wish to have their brown sugar clarified can send it to some of the large refineries, where the operations may be completed and the sugar put up in the usual form of white loaves.

A very large proportion of our agricultural people will doubtless be satisfied with the production of a good syrup from this plant. They may obtain it by following the methods described in the first part of this paper, or they may omit the lime and make an agreeable but slightly acidulous syrup, that will be of a lighter color than that which has been limed.

This syrup is not liable to crystallize, owing to the presence of acid matter. The unripe canes can be employed for making molasses and alcohol, but, as before stated, will not yield true cane-sugar.

ANALYSES OF THE ASHES OF THE CHINESE VARIETY.

I received from Washington an entire plant of the Sorghum saccharatum, with the request that I should determine the composition of the inorganic matter, or ashes of the seed, as well as that of the roots, stalk, and leaves.

The plant, as received in its fresh and ripe condition, weighed 3 pounds 1 ounce, or 49 ounces, avoirdupois. When thoroughly dried, in a current of air heated to 212° F., it weighed 15 ounces, and the loss of water thus ascertained was 34 ounces. The seeds separated from this plant weighed $2\frac{3}{4}$ ounces, and the rest of the plant $12\frac{1}{4}$ ounces.

On burning 1,000 grains of the seeds, I obtained 27.8 grains of grey ashes; and, on analysis, I find the following constituents:

	Grains.
Silica	10.000
Phosphoric acid	6.740
Lime	0.200
Magnesia	3.580

	Grains.
Potash	4.060
Soda	2.270
Chlorine	0.018
Sulphuric acid	0.222
Carbonic acid	0.600
Oxydes of iron and manganese, with loss	0.110
	27.800

The $12\frac{1}{4}$ ounces, or 5,359 grains of the dried plant, without the seeds, burned in a platinum dish, gave 205 grains of grey ashes, which yielded, on analysis:

	Grains.
Silica	85.854
Phosphoric acid	18.245
Lime	33.986
Magnesia	2.870
Peroxydes of iron and manganese	3.034
Potash	30.358
Soda	14.534
Chlorine	1.693
Sulphuric acid	7.702
Carbonic acid	6.560
	204.836
Loss	164
	205.000

The above analyses show what the plant appropriates of the mineral ingredients of the soil, and what must be supplied to the field, if deficient in saline matters.

INVESTIGATION OF THE SUGAR-BEARING CAPACITY OF THE CHINESE SUGAR-CANE.

BY PROFESSOR J. LAWRENCE SMITH, OF LOUISVILLE, KENTUCKY.

On investigating the sugar-bearing capacity of the Chinese sugar-cane, the first step required was to ascertain the true chemical constitution of the juice extracted from the plant. From various conflicting statements on the subject, nothing satisfactory could be gleaned, some of the best authorities insisting that there was not any crystallizable sugar in the juice, or but a very small portion, while others, equally as strong, held the contrary opinion.

It is well known that there are two kinds of sugar of common

occurrence, namely, glucose, or grape sugar, (a sugar moderately sweet and difficult of crystallization,) and cane sugar, with a very sweet taste and easily crystallized. The first form of sugar occurs most abundantly in fruits—the latter in the sugar-cane, the beet-root, maple, melon, &c. I would remark, in addition, that cane sugar is easily convertible into grape sugar, and in all processes for extracting the former, one important aim is to prevent this transformation. For instance, were we to take the juice of the sugar-cane, (containing about 20 per cent. of crystallizable sugar,) and concentrate it without subjecting it to the action of lime or some other defecating agent, fully half of the sugar would be rendered uncrystallizable, and there would be only a small yield of sugar, but a large amount of molasses. For this reason, in regarding the sugar-yielding capacity of any vegetable, the two facts to be considered are, first, the quantity of cane sugar it contains, and, secondly, the amount and character of the impurities associated with the sugar; for the latter, during the concentration of the juice, may give rise to the alteration already mentioned, or they may prevent the sugar from crystallizing without altering it.

The juices of the sugar-cane, beet-root, and maple, present about the best conditions of any of the vegetable juices for furnishing sugar, and according to the care and skill exercised in the working of them, so is the yield of sugar.

Without further preliminaries, I will proceed to state the results of the investigation of the *Sorgho sucré*, as far as possible to make it at the present time. Owing to the season being far advanced, when the experiment was commenced, it was impossible to undertake anything more than a chemical examination of the juice, as the frost had already affected most of the cane which was not cut. Here I would remark, that it is of the utmost importance to examine plants perfectly fresh and unaltered, if we expect correct results in relation to the crystallizable sugar they will produce; and it is a well-known fact that even the broken and bruised canes of a field will deteriorate the juices, if passed through the mill with the perfect canes. Even on the surface which is cut, an alteration commences, at once the sugar is changed, and this alteration gradually creeps from the cut extremity into all joints of the stalk. I have verified this fact in relation to the sorgho. By examining different joints, after it had been cut two or three weeks, the results were as follows, the joints being numbered from the extremity next to the roots:

Juice from joints.	Crystallizable sugar.	Uncrystallizable sugar.
1st joint contained	6 per cent.	7 per cent.
3d joint contained	8 per cent.	4½ per cent.
5th joint contained	9½ per cent.	3 per cent.

Hence it is evident that no time is to be lost, after cutting, in expressing the juice.

Not being able to supply myself with the fresh cane as needed for examination, the structure of the plant, with reference to its sugar-bearing cells, was not investigated. My inquiries, therefore, were directed to the more important study of the composition of the juice.

Some of the sorgho, perfectly matured and recently cut, was compressed, and the juice submitted immediately to analysis. The process adopted for ascertaining the quality and character of sugar is the only one that can be relied on for anything like accurate results. It is known as the process by *polarized light*, in which the juice to be examined is first made in a few moments as transparent and colorless as water, and that without the agency of heat. The juice as compressed is of a light-green color, opaque, and largely mixed with cellulose tissue from the plant. It is readily clarified by acetate of lead, and when thus submitted to examination by Soleil's polarizing saccharometer, three specimens gave the following results :

No. of specimen.	Crystallizable sugar.	Non-crystallizable sugar.
1st	10 per cent.	1½ per cent.
2nd	9½ per cent.	2 per cent.
3rd	10 per cent.	2 per cent.

This result settles the question *that the great bulk of the sugar contained in the sorgho is crystallizable or cane sugar proper.*

The difference of opinion which has existed on this subject, doubtless arose from the fact that different degrees of care had been taken in the concentration of the juice, or that a more or less perfect process of defecation was resorted to, sometimes rendering the juice altogether uncrystallizable, while at others, it furnished a reasonable quantity of sugar.

The results obtained in the analysis of liquids containing sugar by polarized light are especially valuable, as the impurities which may be associated with the sugar in no way affect the accuracy of the analysis, the only requisite being to render it perfectly transparent. Besides the sugar and water contained in the sorgho, the following constituents are found : Cellulose, woody fibre, pectine, pectic acid, albuminous matter, phosphates, sulphates, oxalates, potash, soda and lime salts, starch, and aromatic matter (probably a volatile oil.) Owing to the complex nature of the juice, and the difficulty of its examination, some of the constituents (existing in small quantities) may have been overlooked, but the prominent ones are those recorded in the above list.

Further examination made upon pieces of the stalk showed it to be constituted as follows :

	Per cent.
Water	75.6
Sugars	12.0
Woody fibre, salts, &c	12.4
	100.0

So were it possible to compress all the juice from the cane, there

would be a yield of 87.6 per cent. In some operations, by compression, I have obtained a yield of 66 per cent., but I do not think that the ordinary method of passing the cane between rollers furnishes over 50 per cent. of juice.

The following table gives, at a glance, the composition of the Sorgho sucré, the sugar-cane, and the beet-root:

	Sorgho.	Sugar-cane.	Beet-root.
Water	75.6	72.1	83.5
Sugars	12.0	18.0	10.5
Woody fibre & salts	12.4	9.9	6.0
	100.0	100.0	100.0

Satisfied as to the composition of the sorgho juice, the next step was to examine into some process of separating the sugar. The first method tried was the one transmitted from the Patent Office, and proposed by Leonard Wray. It consisted in treating the cold juice with lime, filtering, then treating with a solution of nut-galls, filtering, again treating with lime, filtering and evaporating to proper consistency, and allowing it to crystallize. This method did not succeed in my hands, the juice becoming very much blackened. All subsequent experiments were made with those methods already successfully practised on the juices of the sugar-cane and beet-root.

The first of these methods is to take the fresh juice, heat quickly to 130° F., add sufficient lime to enable the solution to act on reddened litmus paper, filter, evaporate about a third of the liquid, filter through well-washed animal charcoal; evaporate at a temperature not exceeding 220°, and when sufficiently concentrated, set aside to crystallize.

A second method, which I prefer to the one last mentioned, is to warm the fresh juice rapidly to 120°; then add to each gallon of juice 3 ounces of lime, first slaking it with five or six times its weight of water, then bringing the temperature up to 200°. It is then filtered and carbonic acid passed through the juice, afterwards filtered and evaporated to a proper consistency for crystallization. Each time that the juice is filtered, if it be allowed to pass through well-washed animal charcoal, the syrup may be made very clear, and the sugar prepared from it will be perfectly white. During the evaporation, the temperature should at no time exceed 215°.

It often happens that we have to wait days and even weeks for the crystallization to take place; but it may always be hastened by adding to the thick syrup, when cool, a few grains of brown sugar, or a little pulverized white sugar.

I do not profess to give the methods described as those best adapted to the extraction of sugar from the sorgho, but there are others, not yet experimented with, which may succeed better. Although much of the sorgho syrup which I have tasted is far from being agreeable, yet, when properly prepared, it cannot be readily distinguished from that of the sugar-cane of the tropics.

It must not be forgotten that sugar-making is an art, and cannot be

practised by every one with a mill and a set of kettles; and, moreover, that the sugar-making at present is a vast improvement on that of former days, and where these improvements are not employed, the process is carried on to a disadvantage. Also, in extracting sugar from one vegetable, we are not to expect to apply successfully those methods practised on other vegetables. It was not by applying to the beet-root the method of extracting sugar from the cane that France is now able to produce 120,000,000 pounds of sugar from that root, a quantity equal to one-half of what is consumed by her entire population of 30,000,000. Besides, it was not in a year or two that the beautiful and economical processes now employed were brought to their present degree of perfection. What was necessary for the beet-root is doubtless required for the sorgho, namely, a thorough study of its nature, with a process of extracting the sugar specially adapted to it.

In regard to the economical results to arise from the cultivation of the Chinese sugar-cane, I have no data upon which to form a correct opinion, as it would require an entire season, at least, to go over the subject, and to examine the plant in its different stages; also to examine its fixed principles, and ascertain its exhausting effects on the soil. As already stated, the cane examined was in a perfectly matured state, but I have been informed that, in the earlier stages there, is more sugar in the plant. If this be true, an investigation should be made of its sugar-bearing qualities in the different periods of its growth.

The economical value of this plant, in regard to its sugar or syrup, is far from being settled, even should the syrup be readily converted into sugar. It grows in a temperate climate, it is true, but so does the beet-root, which, under skillful cultivation and a well-directed manufacturing process, will yield from 1,300 to 2,000 pounds of sugar to an acre.

The following are the most important facts established by the present inquiry :

1. The sorgho contains about 10 per cent. of crystallizable sugar.
2. The sugar can be obtained by processes analogous to those employed for extracting sugar from other plants.
3. The uncrystallizable sugar forms rapidly after the cane is fully ripe and recently cut.

The present investigation, I regard only as preliminary to the proper study of the plant in question. Some of the points yet remaining for investigation are—

First, the composition of its ash, compared with that of the sugar-cane, in order to learn its requirements of soil, when compared with those of the latter.

Secondly, the analysis of the plant in certain stages of its growth, and from different localities, to learn when it contains the largest amount of sugar, and what latitude is most favorable for its development.

Accompanying this report are specimens of syrup and sugar ; the former transparent and of a light wine-color, the sugar perfectly white and fine-flavored.

CONDENSED CORRESPONDENCE.

Statement of JOHN D. WHITE, *of Tulip, Dallas county, Arkansas.*

On the 26th of May, I planted one-eighth of an acre with the Sorgho sucré on ground which had been previously prepared for potatoes. The ridges were 3½ feet wide, and the seeds were sown some 2 feet in the drill, from three to eight seed in a hill. The soil was a light-grey sand, and this was the fourth crop. No manure was used, and the land was of that quality which would yield about 20 bushels of corn to the acre.

I ploughed and hoed the crop on the 9th of June, and again on the 30th, after which, we had no rain until the 1st of August, which did not seem to affect it in the least. The plants continued to grow as luxuriantly as though the season was as favorable as possible, while every other species of vegetation was literally parched up. The thermometer ranged 100°, and upwards.

The first panicles appeared about the 20th of July, and ripened the 24th of August. I commenced cutting the cane and crushing on the 2d of September, at which time the average height of the plants was 12 feet. Twenty canes of average diameter, and 9 feet high, weighed, in a green state, 42 pounds, and yielded a little over a quart of juice, which afforded about 17 per cent. of syrup. I made about 14 gallons, pronounced by those who tested it equal, if not superior, to the best golden syrup.

Owing to the inefficiency of my mill, I did not grind more than half of the cane; and I think at least one-fourth, and that the best, of the juice remained in the stalks. My mill was a temporary affair, made only for experimenting. It consisted of two small rollers turned by hand, and the boiling was done in a common clothes boiler. So simple is the process, that any person of the most ordinary comprehension is competent to conduct it. I was unsuccessful in several attempts to make sugar, which may be partly attributable to the failure in extracting the richer part of the juice in the crushing process. As a result of my experiment, I have satisfied myself that an acre will produce 200 gallons of syrup.

My cane shot up new suckers, and promised a second crop, but the frost of the 29th of October destroyed them. They were then just about to put forth panicles, and had already survived several heavy frosts. Stock still eat it with evident relish. Cattle, sheep, and horses are fond of the cane, which possesses excellent fattening properties. Hogs also will eat it voraciously, even after it has been crushed.

In ordinary seasons, the cane may be planted towards the last of March, and thus leave ample time for two crops. The yield of seed is about 30 bushels to the acre.

I estimate the cost of cultivation at about the same as of Indian corn; the gathering at something more. The fodder is superior to that of corn, and in a green state, cattle much prefer the cane. It yields more to a given space of ground, and is a better crop for soiling than anything I have ever tried.

Statement of George E. Smyth, *of Athens, Clark county, Georgia.*

I put down one and a half acres in the Chinese sugar-cane—one-half of the seed in light, sandy soil, the rest in stiff clay. The seed was sown on the 24th of March, in four-foot rows, 1½ in drill, and manured with stable and cow manure.

The crop came up scattering, and was hoed and replanted about the 1st of May. I found that its growth was retarded somewhat by drought, but the plants were not at all injured by slight frost. The panicles first presented themselves on the 1st of August, and opened successively thereafter, and about the 21st they were fully ripe. The stalks attained 12 feet in height, and an average diameter of an inch.

I only pressed out the juice of about three-fourths of an acre of the crop, which produced 15 gallons of good syrup. Some crystals were seen in the syrup, but I could not separate them.

The crop was harvested when the stalks were nearly all yellow, tinged with red. After lying by a week, it was carried to an iron-roller mill, pressed, and boiled immediately. Much of the juice was lost through imperfection in the rollers.

Up to December 1st, my cows were eating the stalks greedily, without their having been previously cut up. I should judge that the cost of production per acre would be about $6, and syrup of the same quality as mine sells here at from 80 cents to $1 a gallon.

If the plants are allowed sucker, by cutting its first crop early, it will produce more syrup to the acre.

Statement of Samuel Logan, *of Blandinsville, McDonough county, Illinois.*

The Sorgho sucré seed, sent me from the Patent Office, grew finely, and the plants attained an average height of 12 feet, although the season was remarkably dry.

The crop of seed was a heavy one, which I intend planting the coming season, as, from satisfactory proofs, I believe it to be profitable, regarded either as a forage crop or for syrup or molasses-making purposes.

Statement of Benjamin Whitaker, *of Warsaw, Hancock county, Illinois.*

I devoted three-fourths of an acre of good wheat land to the culture of the sorgho, planting the seed at three different periods, May 17th and 23d, and the 2d of June. The ground selected was a high ridge, clay soil, one mile from the Mississippi River, and had been under cultivation ten years. A distance of 3½ feet each way was observed in planting. No manure whatever was used with the crop, and it received the first ploughing on the 13th of July, when the plants were knee high. On the 16th and 18th of July, when the mercury stood 102°, Indian corn suffered very much, but the sugar-cane did not wilt in the least. About the 20th of August, it put forth seed-heads, which turned purple on the 22d of September, and ripened

about the 10th of October. The plants, when cut, were from 10 to 11 feet high, the tallest 12 feet, the diameter from 1 to 2 inches.

In crushing the cane, I used wooden rollers, and found, by experiment, at several different times, one hundred stalks produced 11 gallons of the juice, 4 gallons of which made a gallon of excellent molasses. The quantity of molasses may vary with the skill and economy of the producer. All my experiments have been entirely satisfactory.

I might further add that I have also ascertained, by actual trial, that the cane is not so sweet on the rich prairie land, but grows larger and higher than in other locations.

My sugar-cane took the premium at the county fair, as the richest in saccharine properties, and my molasses the premium of $5, as the best exhibited.

Statement of E. H. Bowman, *of Edgington, Rock Island county, Illinois.*

I cultivated an acre of deep, rich prairie loam in sorgho, in four-foot rows, 12 inches in row, on the 23d of May. It was hoed twice, June 15th and 30th, and on July 10th ploughed, and followed by the hoe. On the side of the patch, next to a wheat field, I found the plants attacked by the chinch-bug. It stood drought better than corn, and was not damaged by white frost; a wet autumn retarded ripening and weakened the sap. It put forth its panicles on the 20th of August, yet in October they were not matured. The plants averaged about 10 feet in height, and an inch in diameter. The crop yielded 500 gallons of juice, which was converted into 100 gallons of syrup.

My mode of proceeding with the crop was this: I caused it to be cut, and shocked, like corn, before frost; my mill was of iron, with cast-iron rollers, 15 inches in diameter, and driven by a steam engine. My horses, mules, and cattle have had no other fodder to this date, (December 25th,) and do well.

Statement of Joseph B. Elliott, *of Burnettsville, White county, Indiana.*

From a small package of the cane seed, received last year from the Patent Office, I raised sufficient to plant 50 acres.

I had no conveniences at the time for making syrup, and, therefore, did not attempt it. No other use was made of the crop than as food for my cattle. Next season, I intend manufacturing the syrup, and to experiment further with the plant as a fodder. I observed, last year, that my cattle ate it with the greatest avidity.

I presented each of the members of an agricultural society in the neighborhood, to which I belong, with sufficient seed to plant half an acre; and I have also sent quantities over the county, wherever I have had an opportunity, for experiment.

Statement of JAMES FERGUSON, *of Indianapolis, Marion county, Indiana.*

I planted the seed of the sugar-cane on the 13th of May, in hills $3\frac{1}{2}$ by $2\frac{1}{2}$ feet asunder, putting six grains to the hill. About the 22d, it came up; on the same morning, and also on the 30th and 31st of May, there were severe frosts. They had the effect of killing potatoes, beans, and corn, in the garden, very near the sugar-cane, the blades of which were bitten, but no cane, that I could perceive, was killed outright. I cultivated it with the same care and in the same manner as Indian corn.

The season was remarkably dry and unfavorable for farming purposes, more so than any that had preceded it probably for thirty years. Many fields yielded but 10 to 30 bushels of corn per acre. My crop was from 40 to 45 bushels. I mention this for the purpose of facilitating a comparison between the two, and so determining the relative utility of the plants.

The frost of the 22d of September was so severe as to kill all the tender plants of the garden and fields, including the unripe corn, which was found black and rotted. The sugar-cane escaped in a a measure; most of the blades were killed, and the stalks were bitten in some cases; but, after a few warm days, it put out side shoots, sprouted at the roots, and matured other seeds; much of the first was ripe when the frost occurred.

I now cut about my arms twice full of the cane, and passed it through an ordinary wooden apple-mill of one-horse power, and obtained from it 3 or 4 gallons of juice. This, at the stage for straining and clarifying, was as sweet as the maple syrup. It was raised to a temperature of 190° or 200°, clarified with milk, and skimmed. The white of eggs, blood, or any substance rich in albumen, which coagulates and floats in high heat, answers as well. The juice was reduced to about three-fifths or one-half its former quantity, making a syrup of nearly the same consistency as maple molasses. Undoubtedly the richest part of the juice, in saccharine properties, was not expressed from the cane, owing to the imperfection of the mill. To this, I partly attribute my failure in making sugar. Another probable reason was the accidental burning of the syrup; the frosts might possibly have assisted; yet I think that, if the other processes had been successfully conducted, the frost would not be found to have injured it materially, if at all.

The taste of the molasses produced from the sorgho is excellent. In this opinion, I am sustained by scores who tasted it at our Miami county fair.

No hill in planting contained more than six grains; yet it so sprouted that few, or none, had less than six stalks from 8 to $10\frac{1}{2}$ feet high. I cut nine well-matured stalks from a hill, with the seed fully ripe on all. I did not attempt to gather or use all my crop, because of the imperfection of my mill, and the inconvenient distance of the field from my residence.

I have no doubt of its great value, as a saccharine plant, in this latitude, 40° north, and 1,000 feet above the ocean. I should judge

that about double as many canes as of corn stalks may be grown upon an acre. A good sugar-mill will get from 70 to 75 pounds of juice out of every 100 pounds of stalks, and the juice will make about half its weight in merchantable molasses. Even should it make but 20 per cent., it will pay better than corn at any price it has ever borne.

Statement of J. BARTLETT, *of West Lebanon, Warren county, Indiana.*

I planted the Sorgho sucré on the 17th of May, in a corner of my corn-field, about 3½ feet apart each way, cultivating it in the same manner as corn. The ground was a gravelly clay soil, fresh, but not deep. This was the second crop after clearing; therefore, no manure of any kind was used upon it; but the ground was well prepared before planting.

My custom is to harrow each way with a one-horse harrow, and go each way with a shovel plough; the first time twice, and the second three times in a row. The ground was very dry, no rain falling until the 23d day of June; the soil was then soaked to a depth of about 2 inches, where it had been ploughed. After this, there was another dry period, which lasted until the latter part of August, when we had another good shower. On the 13th, 14th, and 15th of September we had killing frosts, notwithstanding which, the seed of the sorgho matured perfectly.

Neither the stalks, while in the milky stage, nor the seed, were at all injured, but the leaves generally were.

I did not try to extract the saccharine matter from the stalks, contenting myself with the accomplishment of my immediate object in planting the seed, namely, the practicability of readily and profitably raising the crop in this latitude. I am satisfied, however, that it would yield abundance of rich saccharine juice. From my plants, I gathered about a peck of good, heavy seed, which I design planting next season, on a piece of rich, sandy bottom land, and from the crop I intend to attempt the manufacture of molasses.

Statement of PETER H. BRYAN, *of Panora, Guthrie county, Iowa.*

The Chinese sugar-cane prospers well in this section of the country. I should estimate it to yield about 300 gallons of molasses per acre; which, in appearance and taste, is very much like new honey.

Statement of ABRAHAM C. HART, *of Flag Spring, Campbell county, Kentucky.*

The soil was a black, rich, loamy creek bottom, second year from the woods. Before the land was cleared, the timber was sugar-tree and hickory.

Early in May, the ground was broken up with a shovel plough and

two horses; then furrowed out deep with the same contrivance, and planted, three or four cane seeds to the hill. In the after cultivation, nothing was used but the hoe, and that only for the purpose of stir ring the surface and cutting the weeds on two occasions, the ground being kept level, as it was very dry all summer. There were thirty-seven hills and two hundred and sixty-six canes.

Some of the original stalks threw up from one to five suckers each. On the south side of the row of cane, were potatoes, and on the north corn. On the 1st of October, I cut the cane up close to the ground, and set it up by the side of a corn rick, in the open air. In November, I cut off all the seed-heads, which were most of them quite ripe. During that month and the succeeding, I fed out to the cattle and gave away the most of it; so that three months after it was cut, and all that time exposed in the field, I had but eighty-eight canes left, which I carefully weighed, in order to ascertain what quantity of dry fodder may be raised to the acre.

The result was, that about 19,844 pounds, or 9 tons of green plants, and 1,844 pounds of dry leaves, may be obtained per acre. I found that, in comparison with corn fodder, the sugar-cane is surprisingly heavy; that it loses very little weight by drying, and that cattle are extremely fond of it. Discovering these qualities in the sorgho, I began to appreciate its importance to the farmers of this region, simply as a forage crop, apart from its greater value as a molasses and sugar-producing plant.

I raised 1½ pecks of good seed, of which I have given away a gallon within a circuit of 20 miles, and still have frequent demands, which I am always willing to supply. I have also sent small quantities to Massachusetts, Pennsylvania, and Iowa.

Statement of J. W. Martin, *of Loganport, De Soto parish, Louisiana.*

In the latter part of spring, I received from the Patent Office a small paper of the Chinese sugar-cane. Being very late in the season, I concluded to plant but few seeds. On the 29th of June, I put down twenty-seven seeds, from which I gathered one peck, fully matured; and, had the frost not visited us for a month later, I would have saved one-third more.

I have distributed the seed generally through our parish. I fed the blades to my horse, and the cut stalks to my hogs, and they appeared to be remarkably fond of it.

I shall plant about half an acre early this spring. I think it well adapted to this section of the country.

Statement of Ozias Norcross, *of Belchertown, Hampshire county, Massachusetts.*

I set apart about 6 square rods for experiment with the sorgho. This ground was a dry, pebbly soil, naturally poor, but for six years had been largely manured with coarse, raw stuff, from the hog-sty and cow-stable, and well ploughed under every spring.

May the 25th, I planted the seed at distances of 4 feet between the rows, and 3 feet between the hills in the rows. The cane was hoed June the 10th and 22d, and on the 4th and 15th of July. There appeared some slight marks upon the plant of an attack from the stock-worm, as it is termed, which resulted in no injury. I find the cane grows but slowly in wet, cool weather, such as constituted the present season, and thrives best when the season is dryest. The first seed-head made its appearance August the 20th, and they were all out by the 25th; some had well hardened by the 1st of October. The seed will ripen after cutting, in most cases, if due care be taken of it. The average height of my plants was from 11 to 13 feet; very few stalks fell short of 10 feet. The butt ends average $1\frac{1}{3}$ inches in diameter.

I estimate the weight of the green plants to be about a pound, avoirdupois, per square foot; equal to 21 tons to the acre. In drying, the plants lose about one-half of their weight, when green. Properly cured, they amount to about $10\frac{3}{4}$ tons per acre.

I have not yet ventured the cost of machinery, preferring first to ascertain the practicability of raising the crop successfully; and, by testing its value in other respects, determine whether or not its cultivation will be profitable. In gathering the crop, we cut it up with the corn-cutter, and cured it for forage in the same manner as we do Indian corn.

The cost of raising the sugar-cane on our plain lands is about $10 per acre, without estimating the value of manure, which may or may not be necessary. In this climate, we think the seed and fodder best secured by cutting up before severe frosts; slight frosts will not injure it.

Statement of JAMES F. C. HYDE, *of Newton Centre, Middlesex county, Massachusetts.*

My sugar-cane seed was planted on half an acre of light loamy soil, poor, in consequence of having been let out for a number of years.

A compost of stable manure and muck was well applied, and the seed planted on the 20th of May, in hills 2 feet by $3\frac{1}{2}$ feet apart; and, in drills, rows $3\frac{1}{2}$ feet apart, plants 4 to 6 inches apart.

The plants were hoed about the 15th of June, and in the course of their growth, were injuriously affected by excessive moisture. The leaves and panicles were killed by frost about the 1st of October, but the stalks were not at all damaged. The 1st of September, the panicles appeared, but did not eventually ripen. The average height of the stalks was 12 feet, and the diameter of the largest of them $1\frac{1}{4}$ inches.

I obtained 1,600 pounds of dry fodder from the leaves and tops of my half acre; and 750 gallons of juice, which made me 90 gallons of excellent syrup and a small quantity of sugar. I had the cane cut and laid in piles until wanted for the mill; then stripped, and the tops cut off 3 or 4 feet from the end; the stalks were then run through the rollers, each of which weighed 1,200 pounds, worked by two or four

horses. The juice thus expressed was boiled down, in common potash kettles of large size, until it became a syrup of proper consistency. The juice is very rich in saccharine matter, yielding from one-fourth to one-fifth of its bulk in molasses.

I believe the Chinese sugar-cane to be one of the most valuable plants that has been introduced for many years—second in importance to few things that a farmer can grow. Another year, it is desirable that careful experiments should be made with it, in order to test its comparative value as a field crop. Being so rich in saccharine properties, it is a fine article for cows, pigs, and horses, which will eat the stalks, as well as the leaves, with the greatest avidity. The seed, when ripened, is good for fattening poultry.

Statement of DRURY SUMRALL, *of Paulding, Jasper county, Mississippi.*

I planted one-fourth of an acre of rich prairie land with the sorgho, on the 15th of April, in drills 4 feet wide and 18 inches apart. It put forth its panicles the 1st of August, and by the last of the month, the seed was entirely ripe. The plants averaged from 10 to 12 feet in height, and were about an inch in diameter. I then gathered the crop, cutting off the panicles, which produced 50 bushels of seed; and that portion which I designed as forage, I had stacked, butt ends down, to poles 10 feet long, stuck upright in the earth. Here it was suffered to remain three weeks before I hauled to the barn.

My horses and cows ate the fodder and chewed the stalks apparently, with great relish; and I found that if hogs are turned into the field, when the seed becomes ripe, they will eat greedily and fatten very fast. The weight of green plants I estimate to be 20,000 pounds to the acre, and when cured, one-half.

My crop brought $60 for the molasses alone, 200 gallons of which I manufactured, and which readily commanded 30 cents per gallon.

Statement of H. A. BAILEY, *of Chantilly, Lincoln county, Missouri.*

I cultivated about three-fourths of an acre of deep loam and light chocolate soil in the Chinese sugar-cane. The seed was sown on the 21st and 23d of May, 4 feet apart; on the 9th of June, it was worked with the hoe; on the 16th, with hoe and plough; on the 2d of July, with the plough; and again on the 19th of July.

It put forth its panicles about the 1st of September, and by the 15th of October the seed was fully ripe; the height of the plants averaging 12 feet, and thickness 1½ inch in diameter. The stalks were well matured before frost, and when cut, in their green state, would weigh 9,644 pounds to the acre; cured, 5,322 pounds. The yield of seed was about 10 bushels, 7½ bushels of which I saved. I should state the amount of juice to the acre (at the rate produced in my experiment) to be 1,298 gallons; of syrup, 162¼ gallons; the cost of production per acre, including price of seed, $5 40.

The result enables us to approximate the amount of profit per acre from the culture of the sugar-cane, as follows:

162 gallons of syrup, at 40 cents a gallon	$64 80
$7\frac{1}{2}$ bushels seed, at $1 per bushel	7 50
	72 30
Deduct cost of cultivation, price of seed, &c	5 40
Net profits per acre, not including value of stalks, blades, &c., as forage	66 90

My crop was cut with the common corn-knife, stripped, and passed through the mill, which has two vertical rollers, 10 inches in diameter, and 18 inches long, worked with one-horse power.

I should have mentioned, that I found moisture caused the plants to sucker and stool; but that drought had no perceptible effect upon them.

Cut and salted, the crop makes excellent forage for horses and cattle ; and, while green, the seed is good for all kinds of poultry.

Statement of B. A. Alderson, *of St. Charles, St. Charles county, Missouri.*

I planted about one-eighth of an acre of the Chinese sugar-cane. The soil was light and loamy, very little manured; that which was used having been obtained from an old stock lot on a part of the land. On the 24th and 28th of May, I planted the seed in drills, like broom-corn, the rows about $3\frac{1}{2}$ feet apart. On the 15th and 30th of June it was hoed, and ploughed with double shovel. Neither moisture nor drought had any injurious effect upon the crop. By the 25th of September, the seed had ripened; the plants having then attained an average height of from 12 to 14 feet, with a diameter of from 1 to $1\frac{3}{4}$ inches.

The mode I pursued in the manufacture of the syrup was as follows : The cane was topped, stripped of the blades, and, in grinding, was all run through the mill at least three times. I employed a wooden mill, somewhat like the old-fashioned cider-mill, with two upright rollers, 13 inches in diameter, and 18 inches long; a foot of the lower end turned smoothly, and the upper 6 inches fluted, so as to work into each other, and to insure a regular rotary motion. To a swape, I attached one horse, which was amply able to do the work. The wooden journals of the rollers all worked on sheet tin, which destroyed most of the friction consequent upon wood working against wood.

This imperfect machine would grind 100 gallons of juice a day. I made, in all, some 25 gallons of good molasses.

The boiling was done in copper, brass and iron kettles, all seeming to answer the purpose equally well.

The first parcel of thirty stalks, ground four times, gave $2\frac{3}{4}$ gallons.

The second thirty stalks, ground five times, gave 3 gallons.

The third thirty stalks, ground five times, gave 3 gallons.

The fourth thirty stalks, ground six times, gave 2 gallons, 3 quarts, and 1 pint.

The fifth twenty stalks, ground seven times, gave $2\frac{1}{4}$ gallons.

The sixth sixty stalks, ground eight times, gave 5 gallons and 1 pint.

The amount of juice from two hundred stalks of cane was thus 19 gallons, averaging nearly a gallon of juice to every ten stalks, and leaving a very perceptible quantity of juice in each lot ground.

The first lot had been cut thirty-six hours; the second lot, five days; the third lot, six days; the fourth lot, ten days; the fifth lot, ten days; the sixth lot, about fourteen days; average time cut, seven to nine days.

I find that it yielded juice somewhat in proportion to the time it had been cut; the ends having become dry, in some cases, at least a foot down the stalk.

The 19 gallons of juice, when boiled down, made 2 gallons, 1 quart, and $\frac{1}{2}$ pint of good molasses, which is equal to a gallon of molasses to $8\frac{1}{2}$ gallons of juice.

The stalks of cane used in the experiment averaged from 10 to 11 feet long, and were from 1 to $1\frac{1}{2}$ inches in diameter. The large stalks yielded the most juice. Therefore, in cultivating the crop, the stalks should have sufficient room in the drills to allow of their growing to full size.

If there be seventy rows, 3 feet apart, allowing one stalk to each foot in the drill, the yield of juice will be 1,463 gallons per acre; and 8 gallons of juice to 1 of molasses will yield 183 gallons per acre.

A proper mill for grinding the cane would consist of three cast-iron rollers, placed horizontally, so that the cane, when passed through the mill, would come out quite dry. Then, a set of iron kettles, made broad and shallow, ranged in a furnace, so that evaporation might be accomplished rapidly, would be a near approximation to the true method of grinding the cane and making molasses.

I may add, as the result of my exepriment, that the cost of producing the crop is the same as that of Indian corn; that the yield per acre is from 180 to 200 gallons of syrup; and that the farmers of Missouri can make their own molasses and scarcely feel the loss of time.

Bees are fond of the juice, and cows, hogs, horses, and poultry eat the whole plant with avidity.

Statement of M. S. Kimball, *of Fulton, Oswego county, New York.*

From the sorgho seed sent me, I only succeeded in raising the heads; not a seed ripened, although I took especial care to protect the plants from injury by frosts.

With an imperfect crusher, I expressed sufficient juice, when boiled down to the required consistency, to make 113 gallons to the acre of thick, heavy molasses. There remained in the cane yet three-fourths of the juice, which I failed to extract.

The appearance of this syrup was good, but it possessed a disagreeable flavor, which I could not remove, though various expedients were tried.

Statement of HENRY N. BRUSH, *of Brush's Mills, Franklin county, New York.*

I planted a small patch, a rod square, in the Chinese sugar-cane, more from curiosity than from any expectation of its growing. Although the last season was very unfavorable, even for corn, yet the sorgho flourished remarkably well, and withstood the early frosts better than corn; being comparatively green, when corn growing near it was entirely cut down.

Encouraged by this success in its growth, late in November, I attempted by the aid of very rude apparatus to crush the cane, and obtained sufficient juice for nearly 12 quarts of excellent syrup.

I regret that the seed did not ripen, as I desire to cultivate the cane on a larger scale, and would have had abundance of seed for the purpose had it matured.

Statement of JAMES H. HOPKINS, *of Westmoreland, Oneida county, New York.*

Owing to the wetness and lateness of the season, the sorgho was not planted until the 15th of June.

The soil was a light gravelly loam, of rather poor quality—green sward freshly turned over. Upon the same land, adjoining, or rather surrounded by the sugar-cane, I grew 40 bushels of corn to the acre, and 20 bushels of beans, without manure.

I put down half an acre of this land in the sugar-cane, from 3 to 4 feet apart, and worked July 16th with horse cultivator; hoed with the horse-hoe on the 20th of July, and again, by hand, on the 27th of July.

The crop grew slowly until the last of August, then quite rapidly until frost. Moisture injured it from first to last; frost killed the leaves, but had the effect of making the cane sweeter.

The panicles presented themselves about the 20th of September on a small portion of the crop; but the greater part never blossomed, and the seed did not ripen.

The average height of the plant was about 6 feet, and the diameter 1½ inches.

There was so much rain during the season that I could not dry the crop thoroughly, but drew it to the barn in a partly cured state. I judge it to be a very difficult plant to cure at any time, owing to its great juiciness; but my half acre yieded of imperfectly cured forage 3 tons—being 6 tons to the acre. My field was not sufficiently advanced for sugar-making purposes; yet I experimented upon a few stalks, started in a hot-bed, and made a very small quantity of superior syrup.

I would mention, as a peculiar circumstance, that my sorghum, which, before cutting up, was no sweeter than common Indian corn, afterwards grew very sweet, and remained so, save in the joints, many of which became slightly acid.

I preserved the crop in this state and directed it to be cut up at the

roots—the same as Indian corn—and shocked, by placing four small bundles to the shock, and then left in the field until freezing weather, when it was drawn to the barn.

The entire crop was fed to my milch cows; they ate it with avidity, consuming the entire plant, without the waste of a particle.

My horses, calves, colts, and all stock to which it was experimentally fed, appeared very fond of it.

I should estimate the cost of the production of the crop to be $5 per acre, aside from interest on land.

The value of the crop, as forage, I should set at $25 per acre. Had I planted two weeks earlier, upon warmer land, and had the season been an ordinarily dry and warm one, I have no kind of doubt I should have raised a crop of double the value of the present.

I think the sorghum very desirable, as a forage crop, particularly. It is relished exceedingly by all kinds of stock, and is excellent for the production of milk. I place great value upon it as a change, or variation in food, alternated with other forage.

My opinion is that it will do best planted in drills, producing most to the acre in that way.

Statement of M. J. Mudge, *of Nineveh, Broome county, New York.*

I sowed 36 square rods of warm, gravelly green sward, for soiling cows ; and half an acre of clayey loam I planted with sorgho seed, at distances of 3 feet each way. The crop was put down on the 28th of May ; common unrotted barn-yard manure was applied, 30 loads to the acre, and turned under 8 inches deep ; and on the 19th of June and 14th of July, the crop was well worked.

An unusually wet season had the effect of somewhat retarding the growth of the plants, and a severe frost, September 24th, injured the panicles and leaves, but did not at all affect the stalks. In consequence of this frost, none of the seed ripened; I obtained, however, some from seed sown in a hot-bed the 25th of April, which matured, and afforded ripe seeds about the 20th of September.

The cane grown in the field averaged 10 feet in height, and about an inch in diameter. Estimated from the weight of plants in six average hills, I should conclude there were about 20,000 pounds of green plants to the acre, and about 8,000 pounds when cured, similarly estimated. The quantity of juice obtained was at the rate of 960 gallons to the acre, and syrup at the rate of 96 gallons. I did not succeed in making sugar. The cane not being sufficiently ripe, the syrup would not granulate. The refuse part of the syrup, about 10 gallons, made very good vinegar.

My mode of proceeding, in the manufacture of the crop, was as follows: I cut off the tops at the second joint below the panicle, stripped off the leaves downwards, and then cut up the stalks with a corn-cutter, for grinding, &c. The machine employed for this purpose consisted of three wooden rollers, each a foot in diameter, turned with a swape, which was propelled by a horse. This mill was capable of expressing 300 gallons of juice a day, and cost about $10.

The sorgho is manifestly better for soiling than sown corn; horses and cows eat it with avidity, and the fodder will pay for all work up to the time of crushing. In clarifying the syrup, I used lime and new milk. The cost and value of the crop may be thus approximated: Labor, per acre, $16 50; value of fodder, $16 50, which pays for the labor; syrup, worth $72; crushed stalks, worth $5 for manuring purposes, &c.; manufacturing, $20; whole value, $93 50; whole cost, $37 50; to which $20 for use of land and manure, making $57 50, leaving a balance of $36 profit.

Swine are very fond of the stalks in a green state. I think that if the sorgho were planted in good ground, 3½ feet apart, and about four stalks in the hill, in a more favorable season, it would suit this latitude perfectly, and ripen fully.

Statement of JOHN W. BAILEY, *of Plattsburgh, Clinton county, New York.*

I planted 11 rods in the Chinese sugar-cane, at distances of 3 by 1½ feet apart, on the 22d of May. The soil was a gravelly loam, with clay sub-soil, and limestone abundant. I applied stable manure moderately to this piece of land, which was sufficiently fertile, without manure, to produce from 50 to 60 bushels of corn to the acre. At the rate of about 10 two-horse wagon loads only were employed.

On the 20th of June and the 13th and 25th of July, the crop was worked in the manner of Indian corn, namely, by running the horse cultivator through, and following with hoes. The month of June was cold, and the plants made very little progress, being on the 1st of July only about 4 inches high, and yellowish in appearance. The warm weather after July, however, brought them out finely, and the panicles put forth on the 10th of September. They failed to ripen sufficiently, in consequence of the uncommonly wet season, and the white frosts of the 1st and 2d of October. The unfavorable weather did not kill the leaves, curl them, nor had it any other detrimental effect than to arrest the development of the seed. The full-grown plants are far less affected by frost than Indian corn. My crop was cut up on the 17th of October, after several frosts, and only about 3 feet of the tops and top leaves exhibited any evidence of injury from them. The lower leaves and stalks were as green and perfect as possible. The average height of the canes was 10 feet, and the diameter about an inch.

The amount of juice expressed was at the rate of 1,091 gallons to the acre, making syrup at the rate of 116 gallons. I used the common cider-mill for pressing out the juice, and proceeded with the crop in this way: after stripping off the leaves, I cut off about 2 feet from the top, and then cut up the stalks near the ground, with a corn-hook, tied them in bundles, and hauled them to the mill. The cane was then passed between the crushers by hand, the juice running into a tub, and the crushed cane passed off.

The cost of cultivation is the same as corn, and I think, if a proper mill and boiling apparatus were provided, it would pay equally well.

Statement of ISAAC S. FRENCH, *of Loudon Ridge, Merrimack county, New Hampshire.*

The Chinese sugar-cane has been tried to some extent with good success in making syrup, but no sugar has been produced from it in this region, as far as my knowledge extends.

I have the opinion that it is better adapted to feeding stock than for the purpose of making syrup.

Statement of L. F. WILLIAMS, *of Faison's Depôt, Duplin county, North Carolina.*

I planted seven rows of the Chinese sugar-cane, each row 25 yards in length, in ordinary corn land, inclined to be stiff. I applied 2 one-horse loads of yard manure, and planted the seed on the 18th of May, in drills 5 feet apart, and the plants 2 feet asunder in the drills. The crop was worked when occasion required, and withstood drought better than Indian corn.

The sorgho, in my opinion, and that of my neighbors, should be planted as early in March as the season will admit; and the last of September it should be cut for making syrup. My little crop afforded me from 15 to 20 bushels of good seed.

My mill consists of three upright rollers, a foot in diameter, with cogs to suit, at the upper ends; the middle one turned, by fixtures to the top, by horse power, and a proper receptacle provided beneath to receive the juice. It is a simple contrivance, costing from $15 to $20. A fair average yield for our region we may set down at 250 gallons of syrup.

About 6 gallons of the juice will make 1 of syrup.

It will be universally planted in this region next season, as everybody seems delighted with it; in fact, it is just the thing we require.

Statement of THOMAS W. GORDON, *of Georgetown, Brown county, Ohio.*

I divided the sorgho seed sent me into two parts—three-fourths in one parcel, and one-fourth in the other. Both of the gentlemen who raised it for me planted in drills 10 inches apart. One-fourth was planted in rows 4½ feet apart; in this manner about 44 rods of ground were planted, from which was obtained 80 gallons of syrup. The soil cultivated was limestone hill-side, gently sloping south. The seed-heads were not removed from this portion of the cane.

About one-third of the other seed (the three-fourths) did not come up well, and the panicles were subsequently destroyed by incessant rains, the crop being overflown, and thus retarded in growth and overtaken by late frosts. A little of the other two-thirds was destroyed by a worm, which cut through the centre of the stalk when it was from 6 inches to a foot in height. These seed-heads were not removed. This part of the crop produced 126¾ gallons from a little less than half an acre. A portion of this crop was materially injured

by heating in the pile before it was ground. A part of it lay for three weeks, and we were compelled to cut from each stalk the best part of it, in order to avoid juice which had partly soured. I afterwards tried some of this heated cane, which had been raised by a neighbor, and discovered that it made as much and as good syrup as that which had not undergone such change; there being no perceptible difference in the taste.

Frosted cane produced a little less juice, but about an equal amount of syrup as that not frosted. I had one-eighth of an acre deprived of the panicles. The lateness of the season, last year, prevented the plant maturing after the panicle was cut off; and this season, I only obtained 20 gallons of syrup from one-eighth of an acre.

Statement of JOHN A. LAWRENCE, *of Plain P. O., Wayne county, Ohio.*

I selected 40 rods of ordinary clay soil, marked it out with a plough, and sowed the cane seed on the 22d of May. I made the furrows too deep, which I ascertained from the circumstance that when rain fell it produced a crust upon the surface, which wholly prevented the growth of the greater part of the crop—about one-fourth of it only making its appearance. It would be better to plant it on the ridge. I put in the seed 3 by 3½ feet apart in the hills, and in June, went through it with the cultivator and hoe, and again in July. Barn-yard manure was applied to the soil, but the season being very late, the panicles did not appear until August.

Drought has apparently no effect upon the crop, but too much rain evidently impedes its growth. One frost in the fall does not harm it for syrup. In a favorable season, the seed, I believe, would ripen; but owing to the early and severe frosts of the present one, all the seed, I fear, are more or less injured. The plants attained 10 feet in height, and averaged in diameter about an inch. At the rate of from 400 to 500 gallons of juice to the acre were expressed from the stalks, and I should estimate the quantity of good syrup procurable in a favorable season at from 160 to 200 gallons to the acre.

Towards the last of September, I cut the cane up, and cut off the panicles about 10 inches from the top—that portion which, in most instances, is very bitter, and spoils the syrup, if pressed. I then run the stalks through a pair of wooden rollers twice, once being insufficient to extract the best juice in the cane. The fodder is excellent for stock. To plant, hoe, cut, express the juice, and boil into syrup, for the above, cost me $4; making 8 gallons of syrup, worth $1 each, giving a clear gain of one-half net profit, or from $80 to $100 per acre.

I would repeat, that the cane should be planted on a light ridge, as much moisture is a great injury to it, and the plant will pay as fodder alone.

Statement of JOSEPH MCINTIRE, *of Lexington, Richland county, Ohio.*

My experiment was only with about 10 square feet of sandy loam planted May 12th, at 6 inches distance in drills, and worked just as

needed. The plants stood drought very well, but did not come to perfection. They attained the height of 3 feet only, and of course produced no seed. The green plants weighed about 50 pounds; they were fed to my horses, which devoured them greedily.

They can be grown at a cost of about $10 per acre.

Statement of JOHN BOYDEN, *of Brooklyn, Cuyahoga county, Ohio.*

About the 15th of May last, I planted 5 square rods of sandy land, in good condition, with the sorghum. It came up well, but cold weather retarded it for a long time; it finally grew to the height of 10 or 12 feet, but did not ripen, in consequence of frost. About the 1st of October, I began to cut the cane, press out the juice, and boil it down to syrup. The result was, 6 gallons of as pleasant molasses as that of New Orleans, though not so clear, owing to not having been properly cleansed. I used lime for the purpose, but should have had recourse to sub-carbonate of soda, which I think far better.

Owing to the inefficiency of the mill, I did not obtain more than three-fourths of the juice. I should think that about 200 gallons of syrup can be produced to the acre. I succeeded in getting a small quantity of the syrup to granulate.

Statement of J. P. KIRTLAND, *of Cuyahoga county, Cleveland, Ohio.*

The Sorghum saccharatum promises to effect an important change in the condition of the people of the United States, in more than one particular:

1st. In supplying them with a cheap, abundant article in the way of sweetening.

2d. In fattening cattle and swine, it may become as valuable as maize.

3d. In yielding milk, especially from cows in the vicinity of cities.

4th. In affording food for all kinds of grazing stock; for sheep, it must be as valuable in winter as in spring.

5th. Both fermented and alcoholic liquors will doubtless be obtained from it, in great quantities, and perhaps of better qualities than those now in common use.

The plant will flourish as far north as this locality, and anywhere in the vicinity of the lake will mature its seeds.

Statement of HENRY WHEELER, *of Hardin, Shelby county, Ohio.*

I planted the Chinese sugar-cane seed about the 20th of May. The crop grew finely, until arrested and considerably injured by premature, severe frosts, which prevented the ripening of the seed, but did not seem at all to affect the quality of the molasses produced.

I think the use of this plant, as a fodder, will supersede the

necessity of cutting the blades, &c., from corn-stalks, as stock eat the cane, leaves and all, in preference to any other kind of forage. The syrup I have made, I regard as superior to the best molasses from the South.

Statement of Joel T. Meriman, *of Burton, Geauga county, Ohio.*

I planted an acre in Chinese sugar-cane, applying about 20 loads of ordinary yard manure to the soil, and ploughing up clean. I sowed three seeds to the hill, at distances of 4 feet by 20 inches apart, and hoed twice. The season was very wet, and consequently unfavorable to the crop. The seed came up about the 1st of July, and the plants grew rapidly, in due time putting forth panicles; but owing to the heavy frost just as the cane blossomed, the seeds never ripened. I had the land measured by a committee, appointed to decide, and the weight of the green plants ascertained, they estimated it at 34,067 pounds to the acre.

A portion of the cane was then crushed, the juice boiled down, which yielded about 40 gallons of thick syrup; the remainder of the cane, I reserved for fodder, and it proved to be of the very best description. My horses and cattle ate it with the greatest avidity. I kept eleven head of cattle eight weeks upon it, and my cows gave as much and as good milk as from summer feed; the butter, also, which it produced, was of the best quality.

At the same time, I raised a fine crop of turnips among the cane.

I would recommend that turnips should be sowed immediately after the last hoeing which the cane receives, and I think in every instance they will produce well, without the least injury to the cane.

Statement of W. C. Hampton, *of Mt. Victory, Hardin county, Ohio.*

I planted fifteen hills of sugar-cane seed in my garden. It grew with great vigor, notwithstanding the severest drought, and attained the height of 8 feet. It fully matured its seed, standing the fall frosts much better than Indian corn.

A part of my small crop was made into molasses; and I am fully convinced that, with good culture, and the proper means of manufacture, it would yield about 400 gallons of molasses to the acre, equal in every respect t the best New Orleans.

It produces seed abundantly, which, as food for animals, would of itself repay the cost of cultivation.

Statement of F. Avery, *of Delaware P. O., Delaware county, Ohio.*

The 25th of May, in good, clayey, upland soil, I planted the sorgho over a surface of one-fifteenth of an acre. The land was not manured this season; but three years ago, it received a sufficient application of barn-yard manure.

The rows were 4 feet apart, and drilled 8 inches, but not more than two-thirds of the seed germinated. The crop was hoed in the latter part of June.

The plants reached an average height of 12 feet, and were about $1\frac{1}{2}$ inches in diameter. The season being some three weeks later than usual, the cane had not entirely ripened when the period for its manufacture arrived.

My method of treating the crop was this: I first cut off the panicles, and then, with a thin board, constructed with an aperture an inch wide by 12 inches long, I stripped the stalk of its leaves. Next, I cut the cane and hauled to a wooden mill, with three cylinders, 12 by 8 inches, arranged vertically. The machinery was quite imperfect, and did not express more than three-fourths of the juice.

From my small experiment, and what I have seen of it the past season, I think the cost per acre, including its manufacture into syrup, will not exceed $32; and 250 gallons of syrup—a fair yield—at 30 cents a gallon, amounts to $75; making a net profit per acre of $43.

My small crop produced me $247\frac{1}{2}$ gallons of excellent syrup.

Statement of JAMES CASSIL, *of Huntsville, Logan county, Ohio.*

On the 5th of June, I planted 60 rods of black loam and sandy clay soil with the sugar-cane seed, $3\frac{1}{2}$ by 3 feet apart, which I have since been convinced is too close.

The crop was hoed on the 15th of July, and again on the 15th of August. The panicles appeared about the 10th of September, but did not ripen, owing to frost. The plants were not otherwise injuriously affected, the season not being unfavorable; that is, either too wet or too dry.

When sufficiently matured, the crop was cut up, stripped of blades and seed-heads, by hand, and passed through a mill, consisting of two wooden rollers, in a vertical position, and turned by horses attached to a swape. The cost of the arrangement was about $6.

The average height of stalks raised by me was $11\frac{1}{2}$ feet. I found the machinery I employed very defective. Notwithstanding this, I succeeded in procuring 300 gallons of juice, which, after boiling, gave me 30 gallons of excellent syrup.

The entire cost of producing 30 gallons of the syrup was $12. I would recommend that a wider distance be observed in planting the seed than I selected in my experiment, say 4 by 2 feet apart; that the plants be thinned out to three in a hill, and not manufactured until fully ripe

Had my machinery been more perfect, I could readily have procured from the 60 rods 60 gallons of good syrup, which is at the rate of 160 gallons to the acre.

Statement of D. H. Schofield, *of Olive, Noble county, Ohio.*

I planted about 2 rods of clay loam, rich bottom land, that had been cleared fifteen years, with the Chinese sugar-cane, which was the first crop sown upon this piece of land.

It was put down the 23d of May, in rows 3 feet apart, the hills 18 inches asunder in the row. It was hoed, without ploughing, on the 10th of June, and on the 17th of June it was ploughed and slightly hoed.

The season was extremely wet, and altogether unfavorable, there not having been a drought of ten days therein. The sugar-cane stands incessant rains remarkably well; turns somewhat yellow in cold weather, but recovers perfectly as it moderates. Mine put forth its panicles entire by the 5th of September, and by the 12th of October, I adjudged them fully ripe. The average height of the stalks was 12½ feet; some of them reached as high as 15 feet, and were about an inch in diameter. My 2 rods yielded about 40 gallons of juice, which produced about 8 gallons of the syrup.

The cane was cut close to the ground with a corn-cutter, and hauled directly to the mill, where the blades and tops were stripped off. I employed a common cider-mill, and treated the juice in every respect like that of the maple.

Here the cost of production would be about the same as corn, namely, ploughing an acre, \$2; harrowing and crushing, \$1 50; ploughing and hoeing three times, \$5—total, \$8 50.

Statement of John Miller, *of Millersburg, Holmes county, Ohio.*

I sowed the sorgho seed in a sandy soil, over a surface of 10 square rods, on the 23d of May, using about 2 wagon loads of stable-manure during the production of the crop.

The plants were distant 4 feet by 2 apart. The season was very dry until the 23d of September, after which, frost set in, preventing the ripening of the seed. The stalks averaged 12 feet in height, and were about 1¼ inches in diameter.

I used three cogged rollers in my mill, and succeeded in expressing 304 gallons.

Statement of Charles A. Pettibone, *of Girard, Erie county, Pennsylvania.*

The season has been a late and very unfavorable one, not more than one-third of my crop growing, and none of it maturing sufficiently to afford ripe seed. That which did appear, however, grew so thriftily as to vie in stoutness with good Indian corn. I was able to convert but a small portion of the cane into syrup; so, in order to estimate the probable quantity which may be produced to the acre, I was necessitated to measure a part of the ground exhibiting an

average yield, and to obtain a result by calculating its proportion to the acre.

The soil was a sandy gravel, and the seed was planted 3 feet, 9 inches apart, on the 28th and 29th of May, and well worked July the 4th and 5th, and from the 20th to the 25th. The panicles appeared in the early part of September; the plants were from 8 to 10 feet high, and about $1\frac{1}{4}$ inches in diameter, when heavy frosts set in, which killed nearly all the crop, yet by no means unfitting it for the production of as good a syrup, and probably a greater quantity, than is procurable in its green stage.

I erected a mill, at an expense of about $150, which will make $1\frac{1}{2}$ barrels of syrup per day. It takes more force to crush the cane than was expected; consequently, as at present constructed, my water power is quite inadequate to the accomplishment of a satisfactory result. The syrup we have made, notwithstanding all these discouragements, is equal to any from the South. I prefer the taste of the syrup I have produced to any I have tried which was obtained in the green state of the stalk.

I should judge that it takes from 5 to $7\frac{1}{2}$ gallons of the juice to make a gallon of syrup. The mill I used was furnished with two cast-iron rollers; and the crushed cane, after its passage through, was fed to horses and cattle. They eat it more readily than any other forage that grows.

Altogether, I think there has been no plant introduced into our country for the last quarter of a century that has so well realized my expectations as the Chinese sugar-cane.

This is the result of my experiment:

80 gallons of syrup, at $62\frac{1}{2}$ cents per gallon	$50
Cost of cultivation, harvesting, manufacture, use of lands, &c.	40
Balance, which is net profit	10

Statement of JOHN F. WOLFINGER, *of Milton, Northumberland county, Pennsylvania.*

On the 7th of May, I planted, in a mellow, sandy loam, two rows of Chinese sugar-cane, in hills about $2\frac{1}{2}$ feet apart each way, with six or seven seeds to the hill, and from 1 to $1\frac{1}{4}$ inches deep in the ground.

On the 23d of May, the plants made their appearance, and on the 1st of August, the points of the tassels presented themselves. The sharp frost of the 1st of October stopped the growth of the canes, when they were from 10 to 11 feet in height, and averaging an inch thick at the base. The seeds, notwithstanding, continued developing until fully matured.

The Sorgho sucré stands the climate of Pennsylvania finely, retaining its color and luxuriance of growth under a drought that very soon parches and destroys Indian corn. It will also ripen seven or more stalks to the hill, thus producing double the quantity of fodder from the same extent of ground that can be obtained from corn. The

stalks, both in a green and a dried state, abound in a rich saccharine juice, which seems to contain a large amount of fat-forming and milk-producing material. Milch cows and hogs eat it in preference to any other food.

Statement of A. E. Carson, *of Carmichael's*, *Greene county*, *Pennsylvania.*

I planted about 250 square feet of rich sandy loam in the Chinese sugar-cane. It came up well, and grew finely until affected by frost, which was just before the seed matured. Nevertheless, I am confident that it will grow to perfection in this latitude.

The ground I planted, produced about 7 gallons of good, thick, well-flavored syrup. It would be difficult for one unacquainted with the article to distinguish it from sugar-house molasses.

Statement of J. B. Garber, *of Columbia*, *Lancaster county*, *Pennsylvania.*

I chose a limestone soil, which had been in potatoes three previous seasons, and had not been manured, for raising the sugar-cane. The crop was planted on the 16th of May, two weeks later than it should have been, in drills, from 10 to 12 inches apart.

A short drought affected the cane much less than my Indian corn. From the middle to the last of September, the panicles appeared, and the main stalks had ripened about the last of October.

The average height attained by the plants was 14 feet, and the diameter from three-fourths of an inch to $1\frac{1}{2}$ inches. From my quarter of an acre, which was the extent of my planting, notwithstanding full half of the crop was smothered by the weeds when it first appeared above ground, I succeeded in expressing about 420 gallons of juice, and making 70 gallons of very thick syrup, or a gallon of syrup to every 6 of the juice.

Much of the cane being too green when frost was approaching, at the period it was cut, I did not, in consequence, attempt the manufacture of sugar, as I was aware the unripe juice would not granulate. For the same reason, I am unable to state with precision the yield of ripe seed, but I do not think from 30 to 50 bushels per acre an over-estimate.

The machinery I made use of was a three-cylinder cast-iron crusher attached to my threshing horse-power. The juice, previously strained, was boiled in common copper kettles about six hours, with about 4 table-spoonfuls of lime to every 30 gallons of juice

I made no use of the sorgho as a forage crop, but I found my hogs remarkably fond of chewing the cane after its passage through the crusher. I should estimate the cost of production—harvesting, crushing, and boiling—to be very little, if any, more than raising, harvesting, threshing, and preparing for market a crop of Indian corn. An average yield is about 300 gallons of syrup to the acre, which, at 50 cents a gallon, amounts to $150.

Statement of WILLIAM DENNIS, *of Applebachville, Bucks county, Pennsylvania.*

On the 26th of May, I planted in sorghum about one-eighth of an acre of strong, sandy loam, with a sub-soil of sand, gravel, and clay. The rows were about 3 feet apart, and the hills 6 inches.

Hen manure was applied to a portion of the land, and ordinary barn-yard manure to the rest, with about the same result.

The ground was thoroughly worked once only, on the 21st of June. Last season was very dry, and the present is moist, yet I perceive no difference in the growth of the cane, which seems to thrive as well this as it did the preceding year.

The first slight frosts did not injuriously affect the plant in any way, and the heavy frost of the 1st of October merely killed a portion of the leaves, without damaging the stalks.

About the last of August, the seed-heads appeared, and were ripe the 1st of October, when the plants averaged from 12 to 14 feet in height, and from 1 to 1½ inches in diameter.

I cut the crop near the ground with the corn-knife, stripped off the leaves and seed-heads, and passed the stalks twice, some of them three times, through a cider-mill. I found the mill almost useless for the purpose, as by far the greater portion of the juice was retained in the stalks. The little I succeeded in obtaining, I strained carefully and boiled with a small quantity of lime in an iron boiler, removing the scum as it rose to the surface, until it became of proper consistency, and made a very good syrup.

Statement of P. H. HELLEN, *of Uniontown, Fayette county, Pennsylvania.*

With the seed sent me from the Patent Office, and that obtained from other sources, I was enabled to plant 2 acres with the Chinese sugar-cane.

The land selected was rather sandy, with considerable coarse sandstone, the sub-soil clay, with limestone at some depth. Its situation was upland, lying to the south.

The ground was manured with coal ashes and stable manure, abundantly laid on, and ploughed under. May the 26th, the seed was sown, at distances of 4 by 2 feet apart; the crop hoed the 20th of June; ploughed with a three-shovel plough, and hoed July 6th.

The frosts towards the last of October killed the blades, but did not injure the stalks. About the 1st of September, the panicles appeared, and were fully ripe by the 20th of October. The plants then averaged 11½ feet in height, and were from seven-eighths of an inch to 1¼ inches in diameter.

I procured from Cincinnati a mill with boilers, which cost me $100. It has three cast-iron rollers and three kettles, also of cast-iron, designed for boiling and clarifying, two of them holding 30 gallons each, and the other 50 gallons.

The crop produced at least 3,000 gallons of juice, though all that the stalks contained was not obtained. The syrup was clarified by boiling, then permitted to stand twenty minutes, afterwards skimming it carefully and pouring it off.

I found that 7 gallons of the juice made a gallon of good syrup; at which rate, the amount I produced to the acre was 427 gallons, and this without crushing all the cane, a large portion remaining until it became frozen, and unfit for manufacture. I have no doubt the cane will be of great value in all corn-growing regions.

I think it will fatten hogs as well as corn, and an acre is worth more for that purpose; it is as good for swine as clover pasture after the juice is pressed out of the stalks. The cultivation costs about the same as corn.

Statement of Asa Manchester, *of Independence, Washington county, Pennsylvania.*

The land upon which I sowed the sugar-cane was a mixture of gravel and clay, and middling rich.

I planted it in rows 3½ feet apart, each way, alongside of corn, working and hoeing it at the same time and manner as that crop.

The season was very wet, yet the cane grew excellently, attaining an average height of from 10 to 12 feet, with a diameter of about an inch.

A severe hail-storm visited this region, injuring more or less the growing crops ; corn was damaged somewhat, but the sorgho escaped entirely.

The seed-heads appeared on the 1st of September, and ripened about the 15th of October. A portion of the crop sowed upon bottom land did not do so well as the rest.

The machinery and fixtures employed were very imperfect, yet I obtained 200 gallons of good syrup, and the experiment is regarded throughout this county as entirely successful, far surpassing expectations.

My crop was ground in a common cider-mill, and the crushed stalks were fed to the horses, which ate it greedily. Sheep partook of the blades with apparent relish. I think it would be excellent food for them in the winter, when they could not obtain grass; it would have the effect, in my opinion, of rendering them healthy.

Statement of William S. Mellinger, *of Monongahela City, Washington county, Pennsylvania.*

I planted 2,880 square feet of ground, on the 14th of May, with a portion of the sugar-cane seed I had obtained. The soil selected was limestone; the plants 3 feet 6 inches apart, and the crop worked

three times, namly, the 3d of June, 17th of June, and, lastly, on the 1st of July.

The cane grew rank, in consequence of the great moisture of the season, and I found the seed somewhat injured by the frost. It put forth its panicles in the early part of July, when the average height of the plants was 12 feet, and the diameter of the stalks from 1 to $1\frac{1}{4}$ inches.

The weight of the green plants, numbering one thousand two hundred and seventy stalks, was 1,650 pounds.

Notwithstanding the moisture and frost, which prevented the seed ripening, I succeeded in expressing 82 gallons of the juice, which, after the boiling process, afforded me $16\frac{1}{2}$ gallons of good syrup.

The unripe seed, I fed to swine, and, in my opinion, it possesses the same amount of nutriment as the seed of broom-corn.

This was my process in the production of the syrup: on the 1st of October, I bladed and cut the cane, binding the blades in small bundles, and set them up in shocks, removing them when cured.

The cane was passed through an iron mill of two rollers, attached to a steam saw-mill; and the juice, when thus obtained, was boiled down, in iron kettles, to the consistency required.

Cattle and horses are extremely fond of the fodder, either green or cured, and swine will readily feed on the stalks after they are pressed.

The production of the crop costs no more than Indian corn, and, in my opinion, the syrup can be manufactured for from 8 to 10 cents a gallon.

Statement of A. G. SUMMER, *of Pomaria, Newberry district, South Carolina.*

In April last, (1858,) I sowed 20 acres, broadcast, in sugar millet, (Sorgho sucré,) intending it as a pasture for calves and milch cows. On the 1st of July, I turned my cows, sheep, goats, calves, swine, and geese upon it, and have not lost a single animal. They have all improved rapidly; and, although I have large numbers on the field, the herbage bids fair to keep ahead of all demands made upon it. I have fed this plant to all kinds of stock for the four past seasons, in every stage of its growth—green, ripe, and cured as fodder, and have also found it the best soiling crop I ever raised. I fed 250 bushels of the seed during the past winter to sheep, goats, and poultry, and I attach the relative value of oats to it as food for these animals.

This season, I made it a point to take my stock from good pastures, and feeding them well before turning them in, allowing them a plenty of salt. If a half-starved cow is turned on wheat, peas, or Indian corn, she is just as likely to die from over-eating these crops as she is from Chinese sugar-cane. The disease which kills cattle when over-fed on green food in a hungry state is termed "hoove," or "hoven," the best cure for which is a drench of a pint of salt dis-

solved in a gallon of water. This will relieve an animal sometimes in a minute. Peas, of all green food, is the most dangerous, from the flatulent nature of the plant. I have frequently seen half a dozen cows die in a few hours after they were turned into a luxuriant pea-field in the fall, and as frequently have seen others relieved by the above dose.

I have sown broadcast at the rate of one and a half bushels of sugar-cane seed to the acre—a meadow—which I intended to convert into good nutritious hay for winter food. I think more cows will die for the want of this food in our State than from being over-fed on it. I do not think, with the proper precautions, it is in anywise more dangerous than any other green food we are accustomed to feed, and would advise its extended use as a soiling and hay crop in the South.

Statement of O. S. L. Martin, *of Fox Spring, Overton county, Tennessee.*

I received from the Patent Office, on the 9th of June, a small parcel of the seed of the Chinese sugar-cane, which I planted the next day. In five days, the stalks came up beautifully, and continued to grow finely until they arrived at maturity. Owing to the press of other business, I did not commence the manufacture of molasses until two weeks after the seed had ripened; suckers had put up from the roots and some of the joints, and the stalks presented a light yellow. This was in consequence of a frost sufficiently heavy to kill a good many of the blades.

The area of ground planted was a trifle over $3\frac{1}{2}$ square rods, in drills 3 feet asunder. The number of stalks, from 10 to 13 feet high, was seven hundred and fifty; the quantity of seed produced, a bushel; and the number of gallons of molasses produced, was 6.

About one-half the stalks fell down at the time the plants had attained their full size—an evidence of the ground being too fresh and rich. The machinery I employed in expressing the juice, consisted of a couple of rollers fixed horizontally on a bench, worked by cranks to each; a groove had been previously cut in the bench for conducting the juice.

I passed the stalks through twice, doubling them the last time, yet still leaving a good deal of juice in the cane. I found that 5 gallons of the juice, or a little over, will make a gallon of syrup, pronounced by all who have tasted it to be fully equal or superior to the best Orleans molasses.

Statement of Thomas Evans, *of Dandridge, Jefferson county, Tennessee.*

I herewith send you samples of sugar made from the Chinese sugar-cane. I planted the seed about the 17th of April, on river bottom land, in hills laid off for corn, about 4 feet apart each way. Having but few seeds, I apportioned but two to each hill, and subsequently thinned the suckers to four or five stalks to the hill. I began to cut

the crop about the time of pulling fodder, or when the seed had fully ripened. It matured very irregularly, on account of replanting.

Having no way of grinding the stalks, I bored a hole in a piece of timber, and put the large end of the cane into it, and drove in a pin; then, with a stick doubled around the stalks, I twisted them until all the juice it was possible to express by this method was extracted. I boiled this juice twice—the first time insufficiently. After the second boiling, it was set aside in a bowl until morning, when I found that some sugar was collected around the edges. I then put the whole of it in a cloth and suffered the molasses to strain through, leaving the sugar behind. I used lime-water to assist in clarifying.

Statement of G. ROGAN, *of Lockhart, Caldwell county, Texas.*

I received from the Patent Office a sample of the Chinese sugar-cane seed, which I planted about the 1st of March. It came up well, but a portion of it was destroyed by the frost; the balance grew very well, and, notwithstanding the unprecedented drought, matured good stalks and a quantity of fine seed.

Want of time and the smallness of the crop prevented me attempting the manufacture of molasses; but, after the seeds were cut off, some of the young members of my family took a few stalks, mashed them, put them in a common iron pot, poured water over them, and boiled them. They then strained off the water and boiled the stalks again, producing, to my surprise, a fine, richly-flavored syrup. The yield was a large one, considering the crude process employed.

I feel satisfied now of its great merits as a molasses-producing plant, and of its high value as a green fodder.

Statement of STEPHEN S. PERRY, *of Gulf Prairie, Brazoria county, Texas.*

I appropriated to the cultivation of the Chinese sugar-cane an acre of the best Brazos bottom land—alluvial soil, sand, clay, and some lime, with other substances. No manure was necessary, as the soil is of the richest description.

In the month of February, the same time I planted corn, I put down the sorgho, in drills 3 feet apart, ploughing once after planting, and once hoeing the crop, to prevent grass interfering with its growth. On account of the nature of the soil, one ploughing will always be found sufficient in this region.

Though the season was the dryest ever experienced in this State, yet the plants were very little affected, and grew well throughout, putting forth full heads of seed, which matured in about ninety days. The stalks were from 7 to 10 feet high, but smaller in diameter than our common sugar-cane. An acre will produce provender for stock equal to 200 bushels of corn. I did not grind any of the sorgho for sugar-making purposes, simply cutting, curing, and housing it in the crib, for feeding stock.

I have given it to horses, oxen, cows, calves, and poultry, and

think it equal to corn in nutriment. We make three crops a year—one from the seed, and two from the stubble. Like the common cane, it sprouted from the eye, but was later by two weeks in maturing.

I have also made bread from the seed, which was similar in taste to that of buckwheat. Were there any way to bolt the flour, it might be used in that form in preference to corn.

Statement of I. H. S. STANLEY, *of Houston, Harris county, Texas.*

The prevalent opinion, easily controverted, is, that crystallized sugar cannot be produced from the sorgho; consequently, that it is merely valuable for its syrup, and as forage for stock.

I have in my possession two samples of sugar obtained from the sorgho, grown, pressed, and crystallized by Mr. J. I. Studer, of Austin. These were produced under highly disadvantageous circumstances, as he possessed neither suitable mechanical appliances nor good chemical agents for clarifying the juice. Mr. Studer shows, in a communication to the Austin Southern Intelligencer, the botanical relation which the sorgho bears to the broom and early Dourah corns, each being found to vary from the other in its respective proportions of sugar, grain, and fibre; the two latter preponderating when the former scarcely exists, and the sugar abounding in the more cellulose structure of the sugar-cane, but combined with a smaller amount of fibre and grain.

To the juice of the best Louisiana cane, he assigns a specific gravity of 1.068 to 1.075; to the best West India cane juice, 1.07 to 1.09; and to the Chinese variety, as ascertained in different stages, a specific gravity of 1.07 to 1.085. The sorgho, he says, yields a fine syrup, from which, even under the discouraging circumstances mentioned, he repeatedly obtained good results, crystallizing with no more difficulty than that of the common sugar-cane. He further states, that his experiments prove that the best season at which the sugar-making should begin is when the first seed-head is ripe. At this period, a crop of grain of from 30 to 60 bushels, and of juice of from 1,000 to 1,500 gallons, are produced to the acre, the latter yielding from 200 to 300 gallons of syrup. These variable quantities, like the differences in specific gravity, may be ascribed to the varying circumstances of soil, cultivation, and season. The produce in fodder is assumed to be equivalent to 2 tons of hay per acre.

From these data, it cannot be doubted that the introduction of this plant into Texas is a matter of deep importance, meriting richly the earnest attention of cultivators of the soil, especially of upland districts, for which it is especially adapted.

Statement of FREDERICK C. ROBBINS, *of Ludlow, Windsor county, Vermont.*

The Chinese sugar-cane has been planted in quite a number of the gardens near this place and on the farms adjacent; its growth has

been luxuriant, the seed matured, and in many instances, the cane has been cut, and crushed by machinery. The experiment was simply carried to the extent necessary to obtain a correct idea of the quality and quantity of juice the stalk would yield.

The juice appears abundant enough, and sufficiently sweet to make a fine quality of molasses; yet, in a climate where the spring is earlier and warmer, and the autumn about a month later than ours, it would, unquestionably, make a much more profitable crop than in any locality of Vermont.

Statement of M. B. Barton, *of Franklin county, Virginia.*

I planted forty-nine hills, 2 feet by 3 feet apart, with the Chinese sugar-cane seed sent me by the Patent Office. On the 9th of May, two seeds were apportioned to the hill, and the hills well worked with the hoe three times—once when the plants were in the milky stage, and the remainder at the ripening transition of the seed.

The land assigned to the crop was very good; the cane came up well, and grew vigorously to a height of 12 or 14 feet, each stalk averaging two suckers. The juice expressed from the canes, after sufficient boiling in an ordinary iron pot, yielded over $1\frac{1}{4}$ gallons of bright golden syrup, as clear as the best honey.

I would advise, as an important discovery, that the cane should be well worked during the ripening of the seed, as thereby the cultivator will be enabled to procure a brighter and clearer syrup than is otherwise obtainable. The rude apparatus I was necessitated to employ in crushing the stalks failed to extract the greater and most valuable portion of the juice.

The sorgho can undoubtedly be raised in this section to pay good profits—either in the form of molasses produced therefrom, or as a forage plant.

Statement of Ausbert G. Z. Vanlear, *of Long Glade, Augusta county, Virginia.*

I received, last spring, a small quantity of Chinese sugar-cane seed from the Patent Office, which I planted on the 15th of May. By the 15th of October, it had perfectly matured, when I gathered the seed, amounting to at least half a bushel.

I have fed the cane to horses, cattle, and hogs, and they all appeared extremely fond of it. The seed, I partly distributed among my neighbors, desiring to see the plant largely cultivated, as, in my opinion, there is no other fodder equal to it, either in a green or dry state.

Statement of Thomas L. Farish, *of Charlottesville, Albemarle county, Virginia.*

I planted the sorgho on the 20th of May, at which date my Indian corn was 6 inches high.

I cultivated 2 acres of ground in three different soils, in order to ascertain in which description and situation it would best thrive. I used no manure, as I wanted to see whether it would do without it.

One-half acre was a sand-bar on the river; half an acre was a mixture of sand and rich red mud, washed from the hills; and an acre was of rich river bottom land, which would produce 50 bushels of corn to the acre.

The seed was planted 5 feet wide and 2 feet apart, six seeds to each hill, and thinned down to four; new shoots and stalks put forth, and it averaged at least seven stalks to a hill.

About the 15th of June, I ploughed with a one-horse plough; and hoed the crop once in July, and again early in August, which was all the work it received.

The season has been a very wet one, and the cane was all cut before the heavy frosts; two light frosts did it no harm, either to stalk or seed.

About the 20th of July, the panicles appeared, but I did not consider the seed ripe enough to cut until the 25th of September.

The acre situated in the river bottom produced cane which averaged at least 10 feet in height; the half acre on the sand-bar, about 6 feet; the half acre on mixed soil, 8 or 9 feet. The diameter of the largest cane was 1½ inches; the smallest, three-fourths of an inch.

I could not make a very accurate estimate of the weight of the green plants to the acre; but I am satisfied that, on land which will yield 50 bushels of corn, one can get 15 tons of cane. I have as yet, made no estimate of the weight of dry plants, as it is all housed for winter-feeding, except that already ground for molasses. I am sure, however, it will amount to 5 tons to the acre.

I cut the cane as I do Indian corn, and cured it under shelter. Having only a common cider-mill with which to express the juice, I merely ground enough to satisfy me that it would yield well, and make the finest syrup.

From every twenty stalks, I averaged 6 quarts of juice, and one-fourth they contained was left by the mill. I have made sufficient syrup—equal to Stewart's best—to supply my family, of seven persons, for three months. I procured at least 1 gallon of syrup from every 6 of the juice.

My milch cows have been fed upon the cane near three months, and evidently prefer it to any other food, except meal and hay mixed. I had it all cut up for the purpose.

The syrup can be made at about 20 cents a gallon, and the cost of raising the crop is less than that of Indian corn.

I am so well pleased with my experiment, that I shall cultivate 25 acres next year. The dry seeds of the present crop amounted to 20 bushels, weighing 35 pounds per bushel.

Statement of L. L. FAIRCHILD, *of Rolling Prairie, Dodge county, Wisconsin.*

I planted about one-eighth of an acre of good soil in sorghum, which grew to a height of from 10 to 11 feet. A heavy frost on the 30th of September killed the leaves, and injured the stalks.

None of the seed matured, as the cane was cut up just after the appearance of the seed-heads. Before the frost, we had manufactured about 2 gallons of syrup, of fair quality. I estimate the yield to be about 100 gallons of syrup to the acre.

Statement of J. M. STILLWELL, *of Mukwanago, Wauksha county, Wisconsin.*

I sowed the sugar-cane seed in common burr-oak land, rather sandy, previously supplied with ordinary barn-yard manure, well rotted. I planted about 16 rods, putting in the seed about the 18th of May, at distances of 3 to 3½ feet, and hoeing the crop twice.

The season was backward, and a wet one; but I find the cane is not easily affected by superabundant moisture, and stands light frost better than Indian corn.

About the 1st of August, the panicles appeared, and the seed began ripening on and after the 20th of September. The plants were about 11 feet high, and from 1 to 1¼ inches in diameter.

I cut the crop up the second week in October, and crushed it in a small, and very imperfect mill, which did not extract over two-thirds of the juice contained in the cane.

That obtained was boiled in iron kettles, cleansed twice with lime—once for the juice, and again for the syrup.

My 16 rods yielded 17 gallons of very good syrup, and about 3 quarts of seed that was fully ripe.

It will cost about $8 to cultivate, and $16 to manufacture the crop per acre; and putting an ordinary yield at 250 gallons, and the price it commands at 50 cents per gallon, we have a result of $100 as the net profits of an acre.

I think the sorgho is far superior to any English grass in use as forage.

FRUITS AND WINE.

AMERICAN GRAPE-VINES OF THE ATLANTIC STATES.

BY MAJOR JOHN LE CONTE, OF PHILADELPHIA.

Of late years, the cultivation of the vine has become a matter of much importance in different portions of our country. It has been found necessary, however, in the Northern States particularly, to discard the European varieties, as they cannot stand the sudden variations of climate, and from some other cause yet unknown, even in the most favorable situations, are invariably destroyed. About sixty years ago, there was scarcely a yard in the city of New York which did not possess foreign vines producing fruit of the finest quality. Now there are none—they will not grow there. If one is fortunate enough to have them produce fruit for two or three years, they are very apt afterwards, at the time of flowering, to split open, both stem and branches, and consequently perish. I have known vines which must have been flourishing in that city for nearly a century, their stems 6 inches in diameter, and running up walls of more than 30 feet in height. In the garden belonging to the house in which Colonel Aaron Burr lived, about the year 1793, at the corner of Nassau and Cedar streets, there was the finest and most extensive collection of grapes I ever saw. All the choicest varieties that would be found in Europe flourished there, with a luxuriance unsurpassed even in their native climes, not even requiring the slightest protection. At the present time, it would be vain labor to cultivate them; and, out of the city, they need the shelter of a conservatory.

To remedy the want of a grape for the manufacture of wine, it has become necessary to turn our attention to the native species, and to determine which can be best employed. Our country, however extensive and varying in climate, requires, at least, two very distinct classes of plants—the one, suited to the hot regions of the South, and to the rather humid or very dry soils, both of which prevail there; and the other, to the cold regions of the North. Thus the Skuppernong grape can never perfectly ripen north of Virginia, and the Fox grape of the North will scarcely grow in the lower parts of Carolina and Georgia; the Isabella or Catawba varieties of this last, which were originally brought from the upper regions of South Carolina, do not flourish in the low country, and will scarcely live in Lower Georgia.

In all parts of the country, it appears to me that none of the grapes, not even the foreign cultivated varieties, contain as much sugar as those of Europe or Asia. The Skuppernong, as I have known it in Georgia, seems, in respect to the quantity of saccharine matter, to surpass all others. In experiments which I made with the Isabella in New York, I found that the wine produced was very poor and

thin, and that to have a liquor of even tolerable strength, it was necessary to add a considerable quantity of sugar. It may be observed, however, that this grape, in the Northern States, never acquires the richness of taste which it possesses in its native forests. This addition of sugar often imparts a disagreeable taste, which is peculiar and easily detected. To remedy this want of the sweet principle, nothing more is necessary than to boil down the must, before fermentation, until it is considerably reduced.

There is a very prevalent notion in this country, that it is impossible to make wine without alcohol, or even cider, that will keep for any length of time. Consequently, in North Carolina, where the Skuppernong wine is made in large quantities, it is all spoiled by the addition of whiskey, cider, spirits, or peach brandy. They have likewise a custom there of adding honey to the juice after fermentation, in order to sweeten it, thus producing a mixture of wine and half-fermented mead.

In order to show that wine needs no mixture of alcohol to preserve it for any reasonable length of time, it should be recollected that the Romans, who never understood the art of distilling spirits from fermented liquors, speak of wine forty years old, and, again, that beer of different kinds, weaker than any known wine, will keep for a long period.

In attempting to give some account of our American vines, a considerable difficulty is met with in the great similarity of the different species. A family resemblance, almost amounting to identity, exists in all of them—that is to say, in the form of their leaves; but the manner of their growth, and the shape and pedunculation of their fruit, with some minor peculiarities, furnish very good distinctive characteristics.

Before proceeding to a description of the different species, I would remark, that all our American vines require a different treatment from those of Europe; even the pruning of them in the most scientific manner does not appear to produce any good effect; but if left to their own natural growth, they are more productive than when they fall under the hands of the most skillful gardener. I have never seen any vine, comparatively speaking, produce such large crops of fruit as those which were never pruned, and trained upon a stake, being conducted from one festoon to another at such a distance as the length of the stem required. By this means, the clusters of berries hang down from the branches, and have the full benefit of the sun and the air to bring them to a state of the greatest perfection. As several of our grapes cannot easily be propagated from cuttings, we must plant the seed, in order to transport them from their native positions to our gardens and vineyards.

The following are the species best known in the Northern and Middle States:

The common Fox Grape (Vitis labrusca).—Stem large and tall, climbing up trees and over bushes; the younger twigs covered with a cottony down. Leaves large, widely cordate, sublobately angled or five-lobed, irregularly eroded and dentate; above smooth, beneath

irregularly reticulate, densely tomentose or velvety; pubescence of various length, hoary or rufescent. Berries large, round or oval in the common black wild variety; very few on the raceme. In the Northern and Middle States, and extending South as far as the sub-mountainous regions of Georgia, this species is very common. It is the Vitis sylvestris, occidentalis, and vulpina of Bartram; the Vitis latifolia, canina, luteola, rugosa, ferruginea, labruscoides, blanda, prolifica, and obovata of Rafinesque. The so-called "Isabella" and "Catawba" grapes are mere varieties of this species, differing only in the shorter pubescence of the under side of the leaves, and the more numerous berries of the raceme, which have sometimes been as many as twenty or thirty branching off from a common stem, the berries almost always oval; whilst in the wild variety there are seldom more than five or six in a cluster, and these round, frequently oblate, acid and austere, often making the lips sore when much eaten. The Isabella and Catawba, on the contrary, are very sweet and agreeable. But the best of all the varieties is the white-fruited, which does not differ in the leaf from the first described, but the racemes are large, long and dense, the berries oval, white or green, with a slight coppery tinge on the side exposed to the sun. None of our American vines is so worthy of a careful cultivation as this.

Thin-leaved Vine (Vitis tenuifolia).—Stem large and tall; leaves large, thin, widely cordate, simple, trilobate or quinquelobate, acuminate, irregularly dentate, smooth, sometimes arachnoideo-villous beneath, with the nerves always rufous. Racemes small, of three or four berries, which are large, round, green, a little glaucous, disagreeably acid. This species can never be made of any use; it much resembles the preceding, and was once common in the neighborhood of Trenton, New Jersey.

Summer Grape (Vitis æstivalis).—Stem large and lofty; leaves widely cordate, sublobately angled, sometimes distinctly and deeply, three and five-lobed, acuminate, irregularly serrate or dentate; the teeth mucronate; above smooth or a little arachnoidal, especially in the younger stage; beneath more or less fuscous, arachnoideo-villous, sometimes subglabrous, the younger ones more densely villous; racemes rather small; berries small, black, generally very acid, sometimes, however, very agreeable. It grows in the oak lands of Georgia and South Carolina. This is the Vitis æstivalis of Michaux and Rafinesque, the Vitis labrusca of Walter and Elliott. It is commonly called the "Fox grape."

Bract-flowered Vine (Vitis bracteata).—Stem large and tall, climbing to the tops of the highest trees; leaves broad-cordate, acuminate, five-lobed; sinuses wide and deep, the lobes irregularly dentate; the teeth without any mucronate point; above smooth, beneath with the nerves rufo-pubescent; fascicles of the flower with a short leaf or bract at the base of each; racemes long, loose and compound; berries very small, one-tenth of an inch in diameter; very acid. This is the Vitis bracteata of Rafinesque, and æstivalis of Elliott. It is found in Carolina and Georgia in swamps and rich low lands.

Winter Grape (Vitis vulpina).—Stem moderately large, very branch-

ing, the younger shoots, for the most part, purplish; leaves always smooth above, generally so on both sides; beneath sometimes, particularly in the younger ones, a little villous; cordate, acuminate, dentate; the teeth abruptly acuminate, always more or less trilobate, sometimes profoundly so, and often five-lobed; racemes tolerably large, very dense, so as even to change the shape of the berries, which are black, acid, not so much so, however, as to be disagreeable. Among the synonymes of this species, we may mention Vitis cordifolia of many authors, but not of Michaux. Vitis callosa, hyemalis, and cordifolia of Rafinesque, generally known by the name of Winter grape. The name *Vitis cordifolia* has been improperly given to this species, and occasionally to the Vitis rotundifolia of Michaux, but Willdenow's description is sufficient to prove that it is his Vitis vulpina; besides, the grapes have a strong smell, resembling that of a fox. Hence the name *vulpina.* The older leaves are without any villosity beneath, except on the nerves, which, with the vines, are very prominent; they frequently become glaucous beneath.

Cobweb-leaved Vine (Vitis araneosa).—Stem moderately large and high; leaves broad, cordate, sublobately angled, entire, and three and five-lobed, acuminate, dentate; the teeth submucronate; above glabrous, beneath arachnoideo-villous, more or less ferruginous in the older leaves. This villosity forms itself into small tufts or knots, and in the very oldest entirely disappears, although in the youngest it is very thick and close. Racemes dense; berries of a middling size, half an inch in diameter, black, very often sweet and agreeable, sometimes rather acid. The leaves frequently occur 8 inches long, and as many wide. This species is well worth cultivating. It is known as the "Fox grape." I have seen it very common near Athens, in the upper country of Georgia.

Two-colored-leaved Vine (Vitis bicolor).—Stem moderately large and high; leaves broad, cordate, sublobately angled, acuminate, subentire and three or five-lobed, irregularly dentate; the teeth acuminate or mucronate; above smooth, beneath paler; in the younger leaves sparsely arachnoideo-villous, the villosity entirely vanishing with age; racemes long, loose, and compound; berries small, generally sweet and agreeable. Is found from Pennsylvania to Virginia, and is the Vitis æstivalis of Darlington.

Chicken Grape (Vitis pullaria).—Stem moderately large and tall; leaves thin, smooth on both sides, polished. ovate, cordate, abruptly acuminate, beyond the middle more or less trilobed, sometimes five-lobed, often entire, unequally dentate; teeth large, acuminate; petioles and nerves beneath conspicuously pubescent; racemes long, compound, and loose; berries small, much as in the preceding species. Inhabits Virginia and Maryland.

River-side or Shore Grape (Vitis riparia).—Stem large and tall; leaves thin, smooth on both sides, polished, ovate, cordate, acuminate, more or less trilobate beyond the middle, often entire, subcrenately-dentate; teeth broad, flat, with a short point; the youngest leaves with a slight arachnoid pubescence beneath; petioles, nerves, and margin pubescent. The leaves are sometimes five-lobed, the upper lobes

with deep spathuliform sinuses; the margin but little dentate. Racemes loose; berries small, black and acid. This species is confounded by most authors with the next; is found only in the Southern States, on the margins of rivers, in places subject to inundation—whence its name, among the inhabitants of the banks of the Mississippi, *Vigne de battures.* It very much resembles the next species, but is easily distinguished by its thinner leaves, and the pubescence on the under side of them in their younger state. I believe it has been used for making wine.

Fragrant-flowered Vine (Vitis odoratissima).—Stem large and high; leaves smooth on both sides, broad, ovate, cordate, acuminate, unequally crenately-dentate; teeth mucronate, generally obscurely trilobate beyond the middle; nerves beneath very prominent; margin, nerves beneath, and petioles pubescent; a small pubescent tuft at the axillæ of the nerves of the under side of the leaves; racemes long and loose; berries small, black, very acid and austere; ripening in November.

This is the Vitis riparia of Pursh, Torrey and Gray, and others. It is found in the Northern States, in dry situations, generally on the sides of rocky hills. It is much cultivated in gardens on account of its fragrant flowers, the perfume of which is exactly that of the mignonette *(Reseda odorata.)* It very rarely produces fruit. I have found fertile individuals only on the rocky hills north of Hoboken, New Jersey. It is said that the Indians formerly used the juice of this grape for dyeing blue.

Round-leaved Vine (Vitis rotundifolia).—Stem moderately large, unlike every other species, perfectly smooth, even in the oldest vines; leaves thin, smooth on both sides, polished, shining, most so beneath, round, cordate, never lobed, acuminate, dentate; teeth large, subequal, acute; axillæ of the nerves beneath sometimes furnished with a small tuft of pubescence; racemes small, simple; berries large, round, black, reddish or white. Under this species are comprehended the Vitis vulpina of Walter, the Vitis acerifolia, vulpina, angulata, and verrucosa of Rafinesque. In South Carolina and Georgia, it is commonly called "Bullace grape," from its resemblance to the Bullace or wild plum of Europe, corrupted into "Bull grape." In Virginia it is called "Muscadine" and "Skuppernong grape." It most frequently produces fruit of a delicious flavor, and very sweet; probably never comes to perfection north of the State of Maryland. In the pine forests of Georgia, the Vitis rotundifolia is found prostrate, with stems scarcely 3 feet long.

Palmate-leaved Vine (Vitis palmata).—Leaves ovate, cordate, smooth on both sides, deeply five-lobed, palmate, the divisions sublanceolate, unequally and widely crenate or incised; racemes rather dense, subsimple; berries white, with a coppery cheek. This grape, which was first described by Vahl under the name here given, and afterwards by Poiret as the Vitis virginiana, is the true "Bland's grape" of former years; was once extensively cultivated in this city. It has since been entirely lost. I cannot now find a single plant of it. It is found in the mountains of North Carolina and on the banks of the

Ohio. There is certainly no grape found in America which can be campared with it, being in every respect equal to any variety of the European grape. It is very sweet, perfectly free from pulp, with nothing of that peculiar flavor which is more or less common to all other American species. The Vitis cordifolia of Michaux, said to extend from Pennsylvania to Florida, I have never met; at least any species corresponding with his description has never fallen in my way.

There is another small and sweet grape cultivated by many persons, and called "Orwigsburg," which is undoubtedly a European variety, and is therefore omitted in this enumeration of American vines.

Of these twelve species, the most worthy of cultivation are the white variety of the Vitis labrusca, together with the so-called "Isabella" and Catawba, V. araneosa, V. odoratissima, and V. palmata—all of which are more or less sweet, and will furnish good wine.

GRAPE-CULTURE IN MISSOURI.

BY G. C. SWALLOW, OF COLUMBIA, BOONE COUNTY.

Having determined the conditions of soil and climate best adapted to the culture of the vine, it has been the design, during the progress of the geological survey of Missouri, to determine how far these conditions are fulfilled in this State, to what extent and with what success this plant may be cultivated, and the advantages to be derived therefrom. In order to obtain the most accurate data, investigations have been directed to the following points :

1. Persons have been appointed to make meteorological observations, at Springfield, in the South-west; at Cape Girardeau, in the South-east; at Palmyra, in the North-east; at St. Joseph's, in the North-west; and at Columbia, in the centre, in the valley of the Missouri River. These observers have been supplied with the best instruments, and they have made and recorded the results according to the plan adopted by the Smithsonian Institution.
2. The soils have been carefully examined, and all the varieties collected and submitted to a skillful chemist for analysis.
3. The character and habits of all our native vines, and the soils on which they succeed best, have been carefully noted.
4. The experience of our most successful vine-growers has been collected, and the results of their labors compared with the conclusions derived from the examination of the climate, soil, and wild vines.

CLIMATE.

The extremes of heat and cold are not so great as in other vine-growing regions; and in the Southern part of the State, the atmosphere is sufficiently dry; but there are occasional changes of temperature so great and sudden as to prove somewhat injurious to the grape at certain stages of its growth; yet not so marked, in the high table-lands of the South and West, as in the North, and in the valleys of the Mississippi and Missouri.

SOIL.

All the soils of the State are rich enough in potash, soda, lime, magnesia, phosphoric acid, and other mineral ingredients, required for the greatest perfection of the vine; but the argillaceous matter is so abundant in some parts, particularly in the North and West, as to render the sub-soil too compact, wet, and cold, except when it is prepared by underdraining and a proper admixture of sand and other suitable materials. In other parts, the vegetable matter exists in such quantities as to produce a growth too sappy or rank.

The soil upon the bluffs, between Booneville and St. Charles, is generally well adapted to the cultivation of the grape, when the sub-soil is properly prepared. It contains sufficient vegetable matter, and an abundance of all the necessary mineral ingredients. But the soils resting on the bluffs and ridges or highlands of the magnesian limestone region of Southern Missouri, are by far the best to promote the full perfection of the fruit.

NATIVE GRAPES.

The following species and varieties of native vines have been observed in this State, and the growth, habits, and fruit of each have been carefully examined:

Vitis labrusca (Fox Grape).—This vine, which is abundant, attains a very large size in our rich alluvial bottoms, and on our best upland soils, and has often a diameter of 10 inches. It ascends the loftiest trees, and spreads its branches over their highest boughs, presenting a length of more than 130 feet; but the smaller vines, which are found on the poor soils, produce the best grapes. Those which grow upon the dry ridges, on the declivities of the bluffs, especially of the magnesian limestone, and on the slopes of debris at their bases, exhibit a healthy, firm growth, and produce an abundance of fine fruit. The grapes found in these localities are large, and the pulp juicy and palatable. Many well-known and excellent varieties now in cultivation are derived from this species; of these, the "Isabella," "Catawba," "Schuylkill," and "Bland's," are the most esteemed.

Vitis æstivalis (Summer Grape).—This, like the preceding, is found in all parts of the State, and, doubtless, is the largest of all our vines. It is one of the most striking objects in our magnificent forests. While the stem, like a huge cable, is suspended from the limbs of the largest trees, the branches, clothed in rich foliage, and often loaded wite fruit, hang in graceful festoons over the highest boughs. But the vines growing on the thin soils of the limestone ridges and bluffs, and on the loose debris at their bases, where they are more exposed to the air and the sun, produce the best fruit, and in greater abundance.

Vitis cordifolia (Winter or Frost Grape).—This vine is widely diffused, but is not so large as the Fox and the Summer. Its fruit is small and sour.

Vitis riparia (River Grape).—This species is partial to the alluvial soils along the margins of the streams, and grows to a large size.

Vitis vulpina, (Muscadine of the West, and "Fox Grape," according to Elliot, in the South-eastern States).—This species is most abundant in the southern part of the State. It grows very large, and produces an abundance of fruit, which is highly esteemed. The cultivated "Scuppernong" is a variety of this species. On the flinty ridges of the South-west, it is very hardy, and, though small, withstands the annual fires, and yields an abundance of its excellent fruit.

Vitis bipinnata.—This species is found in Cape Girardeau and Pemiscot counties.

Vitis indivisa abounds in the central and western counties.

Remarks.—The success of several of our vine-dressers in this State has been quite equal to their expectations, and their experience has led them to the same conclusions, which have been deduced from the examinations of the soil, climate, and native vines, namely, that the vine can be cultivated with advantage, in favorable localities, in all parts of the State. It should be borne in mind, however, that these results have been derived mostly from vineyards in the valleys of the Mississippi and Missouri Rivers, which are not the most favorable localities; for the "mildew" and "rot," the most formidable obstacles they have had to contend with, may be partially or entirely obviated in some other portions of the State.

"The rot," says Mr. Haas, one of our most successful vine-dressers, "attacks the berries when the soil is in a wet condition, in July and August. It is most severe on the low and wet parts of the vineyard." Mr. Husman says: "The principal cause, all are agreed, is an excess of moisture about the roots, and damp, moist weather." Now, the larger number of our vineyards are located upon a stiff, cold, clayey sub-soil, which unavoidably retains the excess of moisture, and produces injurious effects. This evil may be obviated by thorough draining; or, what is better, by selecting some of the millions of acres in the southern part of the State, the soil of which is warmer, lighter, and richer in the ingredients most favorable to the vine, and the sub-soil sufficiently porous to admit a free passage to the excess of moisture.

The "mildew" appears in June, and is attributed to foggy, damp, and hot weather after rains. From observation, it appears that hot, damp weather, accompanied by mists, is much more prevalent in the valleys of the Mississippi and the Missouri than on the table-lands at the South. The character of the two regions shows, most conclusively, that the excess of moisture must be considerable and permanent. The valleys, which are intersected by broad rivers, are covered with numerous lakes and "sloughs," or with forests of rank growth of considerable extent; but the table-lands are almost destitute of lakes or ponds, and are only partially covered by a sparse and feeble growth of timber; besides, they occupy an elevation several hundred feet above the valleys. No fears, therefore, need be entertained that these obstacles will prevent the entire success of vine-culture in Missouri, should our atmosphere even continue as moist as at present. But we may expect much improvement in this particular, as it is

fully established by experience that the settlement of a country and the opening of the soil to cultivation lessen the amount of rain and moisture in the atmosphere.

Notwithstanding the many difficulties our vine-dressers have had to contend with, and though some of their vineyards are not, to say the least, in the most favorable localities, their success has been encouraging. Those of Booneville have yielded the present season about 6,000 gallons of wine, worth $12,000. One vineyard, of 5 acres, gave a clear profit of $2,000, or $400 per acre. The vintage of Herman was about 100,000 gallons, from less than 200 acres. At $1 per gallon, which is less than the value, it will give a profit of at least $400 per acre, or $80,000 on the 200 acres in cultivation. Another small vineyard at Hamburg, owned by Mr. Joseph Stuley, yielded over 1,000 gallons per acre.

The entire cost of vineyards, preparing the soil, setting and training the vines till they come into bearing, varies from $200 to $300 per acre.

Annual cost of cultivation after bearing	$50 to $60
Ten per cent. on first cost..........................	20 to 30
Total expense per acre, for each year	70 to 90

Judging from the statistics before me, I would estimate that our vineyards have yielded an average of at least 250 gallons of wine per acre since 1849, and have brought a mean price of about $1 60 per gallon, which would give an annual income of $400, or a yearly profit of $300 per acre. The vine-dresser, therefore, even in the poorest seasons, can scarcely fail to realize a handsome profit; while in favorable years his gain will far surpass that of farmers engaged in other branches of husbandry.

Such are the results legitimately derived from the experience of our vine-dressers in their early efforts in a new country, with a soil and climate unknown to this species of culture; and as the climate improves, and the soil is opened to cultivation, other modes of culture will be adopted, and more favorable locations occupied.

The table-lands in Southern Missouri, as has already been intimated, are better adapted to the grape than the sites now occupied in the valleys of the Mississippi and Missouri. That portion of Southern Missouri extending from Newton county, in the South-west, to St. Genevieve, in the South-east, usually represented as the Eastern extremity of the Ozark Mountains, is, in fact, a table-land, varying in elevation from 1,000 to 1,500 feet above the ocean. In the west it is sufficiently undulating to be well drained, while in the east it sometimes rises into ridges and "knobs" of moderate elevation. From this table-land, the country descends by gentle slopes in every direction. The surface of these table-lands is undulating, with no mountains nor arid plains to disturb the equable and agreeable temperature usually prevailing in this region. There are no swamps nor overflown lands from which noxious vapors can arise to render the air damp and unhealthy. As these facts plainly indicate, the summers are long, temperate, dry, and salubrious, and the winters short and

mild. It possesses clear, brilliant skies, and dry, bracing air. The atmosphere is not so moist, nor is it subject to such sudden changes as in the northern part of the State, and in the valleys of the Mississippi and the Missouri.

A series of sandstones and cherty magnesian limestones underlie this whole region, with the exception of some few ridges and knobs of granite, porphyry, and greenstone, in the eastern part. The whole is overlaid with a bed of reddish marly clay. The sand, lime, magnesia, and alumina, derived from the disintegration of these rocks, together with the abundance of vegetable matter and the alkalies. caused by the fires which annually overrun this country, form a soil light, dry, and warm, and rich in the mineral ingredients necessary to render it fertile, and suitable in an eminent degree for the culture of the vine. In many places, this soil is underlaid with a sufficient quantity of pebbles and fragments of porous chert to constitute a most thorough system of drainage, while in others the particles of this rock are disseminated through the soil in such quantities as to injure it somewhat for ordinary cultivation.

The bluffs of the numerous streams in Southern Missouri and in the valley of the Osage usually slope back into knobs and ridges, which are frequently surrounded by numerous natural terraces, so regular and uniform that they appear like the work of human hands. These terraces are produced by the disintegration of the strata of magnesian limestone which form the bluffs. Their height varies from 1 foot to 6 feet, and the width of the top from 2 to 12 feet, according to the angle of the slope and the height of the terrace. Their tops are nearly level, and are usually covered with a light, warm, and rich soil, as above described, containing fragments of chert and the decomposing limestone, all wonderfully prepared by Nature for converting into vineyards. They generally surround high, open ridges and knobs, exposed to the free circulation of dry air.

There appears to be but one objection to the use of these terraces for vineyards. In some places, it is thought that the soil is not sufficiently deep to secure the vine against the effects of drought; but, as an offset to the want of depth, it always contains large proportions of carbonate of magnesia and humus, which give it great capacity for absorbing and retaining moisture, as these substances possess this capacity to a greater degree than any of the other ingredients of our soils. Besides, the thinnest soils on these terraces sustain a vigorous growth of prairie grasses, flowers, shrubs, and vines, which usually produce the finest fruit in the State. It is true, the native grapes do not grow so large and juicy in this as in the richer soils, but the vines are strong and healthy, and produce finer clusters of larger and better grapes—an improvement particularly observed in the Muscadine, the Northern Fox, and the Summer grapes.

This variety of soil also extends over a large portion of the counties on both sides of the Osage, and over the southern part of Boone, Callaway, Montgomery, and Warren, on the north side of the Missouri, occupying, in all, an area of some 15,000,000 acres, of which at least 5,000,000 might be selected in the most desirable localities, and ap-

propriated to vineyards, without encroaching upon the better lands adapted for other crops ; and, so far as can be judged from the characteristics of soil and climate and the indications of the native vines, these 5,000,000 acres in the highlands of Southern Missouri present rare inducements to the vine-dresser, comprising such a combination of circumstances as cannot fail to attract the attention of those who would engage in this most pleasing and profitable branch of rural industry. So important will be the results, that every effort should be put forth to hasten the time when these 5,000,000 acres will be covered with flourishing vineyards, giving profitable employment to 2,000,000 people, yielding more than 1,000,000,000 gallons of wine, and an annual profit, at the lowest estimate, of $50,000,000. The pure, nourishing juice of the grape will then take the place of the vile, maddening compounds used as the names of wine and brandy ; drunkenness will give place to sobriety; and our people, invigorated by the grape and its pure beverage, will become as robust and hardy as they are now daring and indomitable.

There are also numerous caves in all parts of this country, the temperature of those tested ranging between 50° and 60° F. Many of them would make most excellent wine-cellars, their temperature being sufficiently low and uniform to prevent the acidity to which the wines of all temperate latitudes are predisposed.

CULTIVATION OF THE CRANBERRY.

The common American cranberry (*Oxycoccus macrocarpus*) is found growing wild in swampy grounds in the Eastern, Middle and Western States. It grows spontaneously in great abundance in Wisconsin, Minnesota, and Michigan. The latter State is estimated to contain several million acres. Captain Henry Hall, of Barnstable, in Massachusetts, has cultivated this fruit for many years. His method is, to spread on his swampy ground a quantity of sand, in order to kill the grass ; but, where sand is not at hand, gravel will answer the same purpose. He then digs holes 4 feet apart each way, and places in them sods of cranberry plants about a foot square.

Mr. F. A. Hayden, of Lincoln, of the same State, also cultivates this plant. He gathered from his farm, some years ago, 400 bushels, on one occasion, which he sold for $600.

Mr. William Hall, of Norway, in Maine, has likewise succeeded in raising cranberries on a patch of boggy land. He sowed the berries on the snow in the spring. The seed took well and extirpated the weeds. He gathered 6 bushels from a patch of land about 3 rods square, which, a few years since, was entirely useless.

It is well known that this fruit is capable of being transported to Europe, without suffering by the voyage. American cranberries have frequently been sold in London at $8 a bushel, as fresh as when first gathered. This information may be worth the attention of those who have marshy or brook land, as a matter of profit ; and by those

who have ornamental water in their gardens or grounds, it would be found an embellishment to the margins or banks, being an elegant little fruit on the ground, where it trails and spangles the grass with its various-colored berries.

Cranberries may all be raised from seeds, or off-set root-suckers, creeping roots, and trailing rooting stalks. Those also growing with several rooted stalks and branches may be divided in the root and top into separate plants, in which way they succeed very well. The seed should be sown where that method is pursued, in autumn, as soon as they are ripe and gathered, in a shady border, or in the places where the plants are to grow and remain; and, when the young plants are up, they should be kept clean, and be removed, with earth about their roots, as occasion may require The off-sets and root-plants may be set out in the same season in a soil resembling that in which they naturally grow. It may likewise be advisable, in many cases, to take the plants from their natural situations with balls of earth about their roots. They may, in some cases, be removed in the spring season · but removal in autumn is the better way.

The art of raising cranberries consists in selecting a soil that is always damp; and, if flowed with water, in the winter and spring, it is the better. The soil must be loose and barren, so that the cranberry vine, without any cultivation, will overcome and destroy the few weeds and grasses that may spring up. If the soil is fertile, grass and weeds will obtain possession of it, and they can be kept out only by incurring an expense which the crop will never repay.

In Massachusetts, the cranberry crop once in a few years is cut off by the late spring frosts. This may be prevented where a meadow is so situated as to be flowed. The water should not be over one or two inches deep on the cranberries, nor be left on later than the last of May, in this climate. If kept on until it becomes warm, it will kill the vines. Perhaps the best management would be somewhat as they flood rice fields at the South, or water meadows in England—let the water on while the weather is cold, and then take it off as it moderates. Sometimes, in the Eastern States, the cranberries are destroyed by a frost, in September; where water is convenient and plenty, the meadow could be flowed on cold nights at this season, as well as in the spring.

Rakes are now made for the express purpose of gathering cranberries; and, although they tear the vines somewhat, yet the crop is not diminished by raking; on the contrary, it has been increased. Some years ago, a gentleman in Massachusetts commenced raking his little patch of one-fourth of an acre. The first year, it produced 12 bushels, the next 18, the third 25, and so on, until his last harvest, when the crop amounted to 65 bushels. This increase is easily accounted for by the method of gathering with rakes; the pulling up of a few of the vines loosens the ground, and, although not intended, yet, in fact, the raking acts as a partial tillage.

Previous to shipping cranberries, they should be run over a platform slightly inclined. The rotten and bruised fruit will not run off, but stick on the platform, and may be scraped off and thrown

away. The perfect fruit is then put into tight barrels, and, when headed up, filled with water; and in this manner, they arrive in Europe in perfect order, where they have frequently been sold at $20 per barrel.

Cranberries may be preserved perfect for several years, merely by drying them a little in the sun, and then putting them up closely in clean bottles. The red-fruited variety yields a juice which has been employed to stain paper or linen purple. These berries are of great value and importance for different culinary well-known purposes, as in pies, tarts, &c. They are of an astringent quality, and are esteemed good to restore the appetite. They were formerly imagined efficacious in preventing pestilential diseases.

D. J. B.

NOTICE OF SEVERAL INDIGENOUS PLANTS SUITABLE FOR HEDGES.

BY PROFESSOR JOHN TORREY, ASSAYER, UNITED STATES MINT, NEW YORK.

In the United States and Territories west of the Mississippi, especially in Western Texas, New Mexico, Arizona, and Southern California, there are numerous spinescent shrubs which deserve a trial as substitutes for the hedge plants commonly used. Most of these are much better suited for the South than for the North, although it is probable that some of them would bear as severe a climate as that of New England. I will now briefly notice some of the more promising that I would recommend to our horticulturists and agriculturists. As yet, but few of these shrubs have received English names, but the native Mexican designations of many we are able to give. To prevent mistakes, however, we have annexed, in all cases, the proper or scientific appellation, as but little reliance can be placed on popular nomenclature. We also give the natural order, or family, to which the plants enumerated belong.

Of the quassia family, or Simarubaceæ, there are two shrubs which may be used for hedges.

1. *Castela Nicholsoni* (Goat-bush)—a neat, much ramified plant, bearing, besides the short-pointed branches, small thorns, or prickles. It grows in Southern and Western Texas, and we have also received it from Nuevo Leon. The Mexicans call it "Amarguillo," or bitter-shrub. An excellent representation of the plant may be seen in Dr. Gray's Genera Illustrata, Pl. 158. Our wood-cut, (Pl. VII, fig. 2,) gives a good idea of it. The principal figure is taken from a flowering branch.

2. *Holacantha Emoryi* (Emory's Thorn).—This is a very remarkable, thorny and leafless plant, the branches (as in many Cactaceæ, &c.) performing the functions of leaves. It was first discovered by Major Emory, while engaged in a military examination of the country between Missouri and California. He was not so fortunate as to find

it either in flower or in fruit, so that its affinities were not known till more complete specimens were collected by Mr. Thurber. Dr. Gray gave a full description of it in his Plantæ Thurberianæ, p. 310. In the forthcoming volume of the Mexican Boundary Report, there will be an excellent engraving of the plant, from a drawing by Sprague.

The shrub forms dense bunches 5 to 8 feet high, and consists almost wholly of thorns, (as its name implies,) which are from 2 to 4 inches long, and very rigid. It bears small tufts of inconspicuous greenish-white flowers, which are succeeded by star-formed, reddish seed-vessels. A portion of a plant (on a reduced scale) is shown in Pl. VII. fig. 4. If this shrub should prove easy of cultivation, it would form impenetrable barriers to man and beast, but it is destitute of beauty.

3–4. The Barberry family (Berberideæ) furnishes two native shrubs, (*Berberis canadensis* and *Berberis Fendleri,*) which, in some situations, might be used for fencing. Their foliage and fruit are pleasing objects, and the flowers are by no means unsightly. The former species is a native of the mountains of Virginia and some other Southern States. It is distinguished from the European barberry (so extensively naturalized in New England) by its few-flowered racemes and oval berries. Fendler's barberry is a native of New Mexico, and, while resembling the two species just mentioned, is undoubtedly distinct.

5. The staff-tree family, (Celastraceæ,) within the Flora, contains but a single thorny shrub; and this is the remarkable *Glossopetalum spinescens*, so well described by Dr. Gray in the 2d part of his Plantæ Wrightianæ (p. 29, Pl. 12, B.) In the wild state, it seldom attains a greater height than 4 feet, but would doubtless grow taller if cultivated. Its numerous short branches terminate in thorny points, and the small oblong leaves give it a neat appearance.

Among the numerous representatives of the buckthorn family, (Rhamnaceæ,) there are several thorny shrubs, chiefly natives of the country bordering the Rio Grande, of which I shall notice the principal kinds. They constitute the greater part of what the natives call "chaparral," or dense, thorny, impenetrable thickets. These proved exceedingly annoying to our army in Mexico during the recent war. Of the chaparral plants there are three species of "Lote-bush," or jujube, all belonging to the genus Zizyphus.

6. *Zizyphus lyciodes*, an abundant shrub in Western Texas, and in the neighboring Mexican States. It grows from 6 to 8 feet high, and is intricately branched, with oblong, entire leaves and sessile clusters of very small white flowers, which are succeeded by round, black, edible, but rather astringent berries, about the size of a rifle-ball. According to Dr. Gregg, the natives call it "Gerambuyo prieto" and "Cornudo de cuervo."

7. *Zizyphus obtusifolia*, of Gray, (Genera Illustrata, vol. 2, pl. 163,) is closely related to the last, and has nearly the same geographical range, but is most abundant on dry hill-sides along the Rio Grande. The branches are not always spinescent in the wild state, but are most so in thrifty plants.

8. The third species of this genus has been found only in the vicinity of San Felipe, in California, where it was first detected by Mr. Thurber. It is described in the Botany of the Mexican Boundary Survey under the name of *Zizyphus Parryi*, and may take the English name of "Parry's Lote-bush." From the other North American species it is distinguished by its large, woody fruit.

9. *Condalia obovata*, (Pl. VII. fig. 3,) a common shrub in Western Texas and several of the Mexican States. It has a general resemblance to the plants just noticed, and, like them, throws off numerous intricate spiny branches. Dr. Gregg states that its small, round, black berries are called "Capul" by the Mexicans. A complete figure is given in Dr. Gray's Genera Illustrata, vol. 2, pl. 164.

10. *Condalia spathulata* (Narrow-leaved Capul plant).—This species grows in the same places as the last. It is distinguished by its much smaller and narrower leaves, and is a handsome plant.

11. *Adolphia infesta*—another of the thorny shrubs of this family, and one of the most troublesome kinds of chaparral. It is common along the Rio Grande, and is diffused westward to California.

12. *Ceanothus.*—This genus, to which the New Jersey tea, or red-root, belongs, is numerously represented in California and Oregon. All the species are ornamental, at least when in flower. Several of them are remarkable for their rigid spinescent branches, such as the Ceanothus Fendleri, of Southern New Mexico, and Ceanothus divaricatus, of California. The first mentioned is seldom more than two feet high in its native place of growth, but by culture it would become tall enough for hedges. Ceanothus spinosus, of Nuttall, is not appropriately named, as it seldom bears thorns.

13. The rue family, (Rutaceæ,) as represented within our floral limits, contains but a small number of genera and species. The remarkable Kœberlinia spinosa (somewhat doubtfully referred here) is a leafless, much-branched and thorny shrub, 5 to 10 feet high, which is found near the Rio Grande, in Western Texas, and in the neighboring parts of Mexico. The whole plant is of a yellowish-green color. The ultimate branches terminate in formidable thorns, which are from an inch to four inches in length. These bear on their sides and in their axils small clusters of white flowers. The general appearance is that of Emory's thorn (*Holacantha Emoryi.*) The Mexicans of Coahuila and Nuevo Leon call it "Junco."

14–17. Another genus of this family is Zanthoxylum, of which there are three species in the United States, namely, Zanthoxylum americanum, which is the "Prickly ash" of the Northern States; Zanthoxylum carolinianum, the Prickly ash of the Southern States; and Zanthoxylum pterota, a native of Key West, as well as of the countries along the Rio Grande. The last has received no common name, either English or Mexican. All these plants are armed with strong prickles, although they do not bear thorns.

The great family of the Leguminosæ contains only a few thorny plants, which belong to Western Texas, and the regions adjoining. The well-known "Mesquit" is one of these.

18. *Algarobia glandulosa* (Mesquit). It often becomes a middle-sized

tree, but it can easily be kept of any required height by clipping. Its foliage is graceful, being not unlike that of the honey-locust (*Gleditschia triacanthos.*) Usually, a pair of sharp thorns is produced at the base of each compound leaf. The only figure of the plant is that given in the Annals of the Lyceum of Natural History of New York, vol. 2, pl. 2.

19–20. Nearly allied to the Mesquit is the Screw bean (*Strombocarpa pubescens*), so remarkable for its spirally-twisted pod. The flowers, which are fragrant, are in close cylindrical racemes. A good plate of this species is given in the Botany of the Pacific Railroad Exploration, vol. 4, pl. 4, and our own figure represents the plant very well. (Pl. VII. fig. 1.) On the lower Rio Grande is a smaller species of screw-bean, (*Strombocarpa cinerescens*, Gray,) which bears the flowers in compact, globose heads. Both kinds, doubtless, could be easily cultivated.

21–22. Among the numerous plants of the mimosa tribe, or sub-order of Leguminosæ, are several Texan and New Mexican species, which bear strong prickles, and being shrubby, as well as of quick growth, they may be tried as to their suitableness for hedges in the Southern States. Those that seem to deserve especial notice for this purpose are the *Mimosa biuncifera* and *Mimosa borealis*, known among the native Mexicans by the name of "Uña de gato," or "Uñagato." The Americans call them "cat-claws."

23–24. The rose tribe (Rosaceæ), although very extensive, contains but few plants of the right qualities for fencing, and most of these belong to the genus cratægus. The favorite hedge plants in this country are two or three native species of that genus. The well-known Washington thorn (*Cratœgus cordata*)—a native of Virginia, Kentucky, and the States southward. The "Cockspur thorn," (*Cratœgus crus-galli,*) a common species east of the Mississippi. It is easily distinguished by the entire and somewhat leathery, narrow, and dark-green shining leaves. The thorns are very long and sharp. Of all the species of cratægus, this is generally admitted to be the best for hedges.

25. The singular genus Fouquiera (of doubtful family, but apparently nearer Polemoniaceæ than Portulaceæ) contains three species, one of which is quite abundant on the Upper Rio Grande and in the Northern Mexican States. This is the "Ocotillo" of the Mexicans, *Fouquiera splendens.* It is armed with numerous sharp thorns, which are the persistent mid-ribs of the primary leaves. The stem is much like that of some Cactaceæ. It bears panicles of splendid scarlet flowers. In some parts of New Mexico, the natives have long used it to form hedges around their gardens. A plate of the plant is in Emory's Report of his Military Expedition to California. A second species occurs in Sonora.

26. The next group of plants containing thorny shrubs is the nettle family. Here we find the valuable Osage orange, or Osage thorn (*Maclura aurantiaca* of botanists.) This is a native of Arkansas, Western Louisiana, and Eastern Texas. It is said also to occur in the southern part of Missouri. It came into use as a hedge plant

about twenty-five or thirty years ago, and is now well known throughout the country. On account of its strong growth and thorny branches, it forms a barrier that few animals can pass through; but it shoots forth such long and vigorous branches that it is difficult to keep it within bounds.

26. Among the chaparral bushes growing along the Rio Grande, in Western Texas, Coahuila, Nuevo Leon, &c., a thorny species of Celtis deserves notice here, as it is one of the most promising of our hedge plants. It is the "Cranjeus," or "Cranxero" of the Mexicans. Under the name of *Celtis cinerea* it will be described, and a plate of it given in the forthcoming volume of the Mexican Boundary Survey. Its usual height is from 6 to 10 feet, very much branched, the branches being rigid, and armed with short but strong spines. The leaves are oval, about an inch long, and either toothed or entire. The flowers are polygamous, very small, and of a greenish-white color. The berries are the size of small peas, of an oval form, orange-yellow, and somewhat edible, though astringent. The plant usually grows in poor, stony soils, and, as our soldiers and American travellers report, it forms the most annoying kind of chaparral.

HORTICULTURE.

PRINCIPLES OF HORTICULTURE.

[Condensed from a "A Guide to the Orchard and Kitchen Garden," by John Lindley, M. D.]

No greater boon could be bestowed upon the gardening world than to reduce all horticultural operations to their first principles, and to lay bare the causes why in one case one mode of procedure is advisable, and another in another. But there are few persons who are competent to undertake this task. It requires a combination of great physiological knowledge with a perfect acquaintance with the common manipulation of the gardener's art, and much experience in all the little accidents which are scarcely appreciable by the most observing cultivator, with which the mere man of science can necessarily have no acquaintance, but upon which, the success of a gardener's operations often mainly depends; which are to the cultivator signs as certain of the issue of his experiments as to the mariner are the almost invisible changes in the appearance of the heavens by which the weather is prognosticated.

Deeply impressed with a persuasion of the justice of the foregoing observations, and sincerely regretting that there should be no present expectation of such a task being undertaken by any one fully competent to it, the writer ventures to throw himself upon the indulgence of the public in attempting, not to carry into effect such a plan himself, but to sketch, in regard to the fruit-garden, what he thinks should be the method upon which a more competent person would do well to proceed.

All our fruits, without exception, have been so much ameliorated by one circumstance or another that they no longer bear any resemblance, in respect of quality, to their original. Who, for instance, would recognize the wild parent of the Coe's, or Green Gage plum, in the savage Sloe; or that of the Ribston and Golden Pippin apples in the worthless acid Crab? or what resemblance can now be traced between the delicious Beurré pears, the flesh of which is so succulent, rich, and melting, and that hard, stony, astringent fruit which even birds and animals refuse to eat? Yet these are undoubted cases of improvement resulting from time and skill patiently and constantly in action. The continual dropping of water will not more surely wear away the hardest stone, than will the reason of man in time compel all nature to become subservient to his wants or wishes. But it would be of little service to mankind that the quality of any fruit should be improved, unless we found some efficient and certain mode of multiplying the individuals when obtained. Hence, there are two great considerations, above all things, to which it is necessary that

the attention of the cultivator should be directed, namely, amelioration and propagation.

Amelioration consists either in acquiring new and improved varieties of fruit, or in increasing their good qualities when acquired. It will be as well to consider these two subjects separately.

By what means the first tendency to change their nature was given to domesticated plants, we are entirely ignorant. It is probable that it was originally due to accident, and also that it was still mere chance which continued to operate down to very modern times. Philosophers are unacquainted with the reason why there should be any tendency to variation from the characters first stamped on any species by Nature; but all know that this tendency does exist, and in a most remarkable degree, in many species. There is in all beings a disposition to deviate from their original nature when cultivated, or even in a wild state; but this disposition is so strong in some, as to render them particularly well adapted to become subject to domestication. For instance, the dog, the pigeon, and the barnyard fowl are cases in which this tendency is most strongly marked in animals; and domesticated fruits are a parallel case in the vegetable world.

Without, then, vainly endeavoring to discover the first cause of this disposition to form varieties, let us take it as a fact that the disposition exists. Cultivators increase this disposition chiefly in two ways: either by constantly selecting the finest existing varieties for seed, or by intermixing the pollen and stigma of two varieties for the purpose of procuring something of an intermediate nature. The ancients were unacquainted with either of these practices, and consequently their gardens contained few things which would now be deemed worthy of cultivation. The power of obtaining cross-bred varieties at pleasure has only existed since the discovery of sexes in plants; but as it exerts a most extensive influence over alterations in the vegetable kingdom, it may be considered the most important controlling power that we possess.

In *sowing seeds* for the purpose of procuring improved varieties, care should be had not only that the seeds be taken from the finest existing kinds, but also that the most handsome, the largest, and the most perfectly ripened specimens should be those that supply the seed. A seedling plant will always partake more or less of the character of its parent, the qualities of which are concentrated in the embryo when it has arrived at full maturity. How this concentration takes place, we are as ignorant as why certain constitutional peculiarities are in men transferred from father to son, and from generation to generation; but we know that it does take place. Now, if the general qualities of a given variety are concentrated in the embryo under any circumstances, it is reasonable to suppose that they will be most especially concentrated in a seed taken from that part of a tree in which its peculiar good qualities reside in the highest degree. For instance, in the fruit of an apple growing upon a north wall there is a smaller formation of sugar than in the same variety growing on a south wall; and it can be easily understood that the seed of that fruit which is itself least capable of forming saccharine secretions will

acquire from its parent a less power of the same nature than if it had been formed within a fruit in which the saccharine principle was abundant. It should therefore always be an object with a gardener, in selecting a variety to become the parent of a new sort, to stimulate that variety by every means in his power to produce the largest and the most fully ripened fruit that it is capable of bearing. The importance of doing this is well known in regard to melons and cucumbers, and also in preserving fugitive varieties of flowers; but it is not generally practised in raising fruit-trees.

The *power of procuring intermediate varieties* by the intermixture of the pollen and stigma of two different parents is, however, that which most deserves attention. We all know that hybrid plants are constantly produced in every garden, and that improvements of the most remarkable kind are yearly occurring in consequence. Experiments, however, it may be supposed, are sometimes made without the operator being exactly aware either of the precise nature of the action to which he is trusting for success, or of the limits within which his experiments should be confined.

Cross-fecundation is effected, as every one knows, by the action of the pollen of one plant upon the stigma of another. The nature of this action is highly curious. Pollen consists of extremely minute hollow balls or bodies. Their cavity is filled with fluid, in which swim particles of a figure varying from spherical to oblong, and having an apparently spontaneous motion. The stigma is composed of very lax tissue, the intercellular passages of which have a greater diameter than the moving particles of the pollen.

When a grain of pollen comes in contact with the stigma, it bursts and discharges its contents among the lax tissue upon which it has fallen. The moving particles descend through the tissue of the style, until one, or sometimes more of them, finds its way, by routes specially destined by Nature for this service, into a little opening in the integuments of the ovulum, or young seed. Once deposited there, the particle swells, increases gradually in size, separates into radicle and cotyledons, and finally becomes the embryo—that part which is to give birth, when the seed is sown, to a new individual.

Such being the mode in which the pollen influences the stigma, and subsequently the seed, a practical consequence of great importance necessarily follows, namely, that in all cases of cross-fecundation the new variety will take chiefly after its polliniferous or male parent, and that, at the same time, it will acquire some of the constitutional peculiarities of its mother.* Thus, the male parent of the Downton strawberry was the Old Black, the female a kind of Scarlet; in Coe's Golden Drop plum, the father was the Yellow Magnum Bonum, the mother the Green Gage; and in the Elton cherry the White Heart was the male parent, and the Graffion the female.

The limits within which experiments of this kind must be confined are, however, narrow. It seems that cross-fecundation will not take

* In early crosses between distinct species, this is particularly manifest; but in those of varieties long domesticated it is less apparent, the distinctions between the parents themselves being less fixed, and less clearly marked.

place at all, or very rarely, between different species, unless these species are nearly related to each other; and that the offspring of the two distinct species is itself sterile; or, if it possesses the power of multiplying itself by seed, its progeny returns back to the state of one or other of its parents. Hence it seldom or never has happened that domesticated fruits have had such an origin. We have no varieties raised between the apple and the pear, or the quince and the latter, or the plum and cherry, or the gooseberry and the currant. On the other hand, new varieties obtained by the intermixture of two pre-existing varieties are not less prolific, but, on the contrary, often more so than either of their parents. Witness the numerous sorts of Flemish pears which have been raised by cross-fecundation from bad bearers within the last forty years, and which are the most prolific fruit-trees with which gardeners are acquainted; witness also Mr. Knight's cherries, raised between the May Duke and the Graffion, and the Coe's plum already mentioned.

It is, therefore, to the intermixture of the most valuable existing varieties of fruit that gardeners should trust for the amelioration of their stock. By this operation, the pears that are in eating in the spring have been rendered as delicious and as fertile as those of the autumn; and there is no apparent reason why those very early but worthless sorts—such as the Muscat Robert, which usher in the season of pears—should not be brought to a similar state of perfection.

There is no kind of fruit, however delicious, that may not be deteriorated, or however worthless, that may not be ameliorated by particular modes of management; so that, after a given variety shall have been created, its merits may still be either elicited or destroyed by the cultivator. In this place, those practices only need be considered that tend to improvement.

Some fruits of excellent qualities are bad bearers. This defect is remedied by a variety of different methods, such as—

1. By ringing the bark.
2. By bending branches downwards.
3. By training.
4. By the use of different kinds of stocks.

All these practices are intended to produce exactly the same effect by different ways. Physiologists know that whatever tends to cause a rapid diffusion of the sap and secretions of any plant causes also the formation of leaf-buds instead of flower-buds; and that whatever, on the contrary, tends to cause an accumulation of sap and secretions has the effect of producing flower-buds in abundance. This circumstance, which at first sight seems to be difficult to account for physiologically, is no doubt to be explained by the difference between leaf-buds and flower-buds themselves. In a leaf-bud, all the appendages or leaves are in a high state of development, and the central part, or axis, around which they are arranged, has a tendency to extend itself in the form of a branch as soon as the necessary stimulus has been communicated to the system by the light and warmth of spring. In a flower-bud, the appendages or leaves are in that imperfectly formed, contracted state which we name "*calyx*," *corolla*, *stamens*, and *pis-*

tils; and the central part around which they are arranged has itself no tendency to elongate under the influence of the usual stimulants. Hence, a flower-bud, or flower, is nothing but a contracted branch, as is proved by the occasional elongation of the axis in flowers that expand during unusually hot, damp weather late in the spring, becoming branches, bearing sepals and petals instead of leaves. It is, therefore, easy to be understood why, so long as all the motions in the fluids and secretions of a tree go on rapidly, with vigor, and without interruption, only rudiments of branches (or leaf-buds) should be formed; and why, on the other hand, when the former become languid, and the parts are formed slowly, bodies of a contracted nature, with no disposition to extension, (or flower-buds,) should appear.

It will be found that the success of the practices above enumerated, to which the gardener has recourse in order to increase the fertility of his fruit-trees, is to be explained by what has just been said. In *ringing* fruit-trees, a cylinder of bark is cut from the branch, by which means the return of the elaborated juices from the leaves down the bark is cut off, and all that would have been expended below the annular incision is confined to the branch above it. This produces an accumulation of proper juice, and flower-buds, or fertility, are the result. But there is a defect in this practice, to which want of success, in many cases, is no doubt to be attributed. Although the returning fluid is found to accumulate above the annular incision, yet the ascending sap flows along the alburnum into the buds with nearly as much rapidity as ever, so that the accumulation is but imperfectly produced. On this account, the second practice, of *bending branches downwards*, is found to be attended with more certain consequences. The effect of turning the branches of a tree from their natural position to a pendulous or a horizontal one, is to impede both the ascent and descent of the fluids in a gradual but certain manner. The tissues of which branches are composed is certainly permeable to fluids in every direction; and there can be no doubt that the vital action of the vessels of a plant is performed both in the natural and in an inverted position. So long as that erect direction of the branches, which is natural to them is exactly maintained, the flow of their fluids, being subject to no interruptions, will take place in the freest possible manner; but the moment this natural direction is deviated from, the vessels become more or less compressed, their action impeded, and finally, if the inversion is perfect, it becomes so slow that an accumulation of the proper juices necessarily takes place through every part of the system.

One of the objects of *training* is to produce the same effect. Branches are bent more or less from their naturally erect position; their motion, in consequence of the action of winds upon them, which is known to facilitate the movement of the fluids, is totally destroyed; and hence arises the accumulation of proper juice which is necessary to their fertility. Nor is the *influence of the stock* of an essentially different nature. In proportion as the scion and the stock approach each other closely in constitution, the less effect is produced by the

latter; and, on the contrary, in proportion to the constitutional difference between the stock and the scion, is the effect of the former important. Thus, when pears are grafted or budded on the wild species, apples upon crabs, plums upon plums, and peaches upon peaches or almonds, the scion is, in regard to fertility, exactly in the same state as if it had not been grafted at all; while, on the other hand, a great increase of fertility is the result of grafting pears upon quinces, peaches upon plums, apples upon whitethorn, and the like. In the latter cases, the food absorbed from the earth by the root of the stock is communicated slowly and unwillingly to the scion: under no circumstances is the communication between the one and the other as free and perfect as if their natures had been more nearly the same; the sap is impeded in its ascent, and the proper juices are impeded in their descent, whence arises that accumulation of secretion which is sure to be attended by increased fertility. No other influence than this can be exercised by the scion upon the stock. Those who fancy that the contrary takes place—that the quince, for instance, communicates some portion of its austerity to the pear—can scarcely have considered the question physiologically, or they would have seen that the whole of the food communicated from the alburnum of the quince to that of the pear is in nearly the same state as when it entered the roots of the former. Whatever elaboration it undergoes must necessarily take place in the foliage of the pear, where, far from the influence of the quince, secretions natural to the variety go on with no more interruption than if the quince formed no part of the system of the individual.

If we consider upon what principle the *flavor of particular fruits may be improved*, we shall find that it is entirely due to the increased action of the vital functions of leaves. When the sap is first communicated by the stem to the leaves, it has experienced but few chemical changes since it first entered the roots. Such changes as it has undergone have been due rather to the solution of some of the pre-existing peculiar secretions of the individual by the sap in its way upwards through the alburnum, than to any other cause. As soon, however, as it enters the leaves, it becomes altered in a variety of ways, by the combined action of air, light, and evaporation; for which purposes the leaf is admirably adapted by its anatomical structure. Thus altered in the leaves, it ceases to be what we call sap, but becomes the proper juice; or, in other words, acquires the peculiar character of the final secretions of the individual from which it is formed. Discharged by the leaves into the bark, it is thence conveyed, by myriads of channels of cellular substance, throughout the whole system. From these secretions, of whatever nature they may be, the fruit has the power of attracting such portions as are necessary for its maturation. Hence it follows, that the more we can increase the peculiar secretions of a plant, the higher will become the quality of its fruit; and that, on the other hand, the less the plant is in condition to form those secretions, the less will be the quality of the fruit. It is for the purpose of producing the former effect that pruning and training trees are more especially destined. In *pruning*,

we remove all those superfluous branches which overshadow the remainder, and we endeavor to expose every part to the freest action of light and air. In *training*, the same thing takes place, but is increased; there is not a branch that is not fully exposed to the most direct rays of light, and to the freest circulation of air, and even to the unimpeded action of the sun in aspects exposed to the south, east, or west. This action is obviously most powerful on the south, and hence the higher quality of fruits matured upon that exposure than on any other; while, on the other hand, fruits raised upon a northern aspect are well known to be less highly flavored than those from even an open standard. For a similar reason, forced fruits, which are obtained at a period when there is little light, cannot be compared with those which are matured in the full blaze of a summer sun; and hence, melons grown in frames covered with mats, and carefully excluded from the influence of that solar light which is indispensable to them, have, whatever may be their external beauty, none of that luscious flavor which the melon, when well cultivated, possesses in so eminent a degree.

The next subject of consideration is the mode of multiplying improved varieties of fruit, so as to continue in the progeny exactly the same qualities as existed in the parent. Unless we have the power of doing this readily, the advantages of procuring improved races would be very much circumscribed; and the art of horticulture, in this respect, would be one of the greatest uncertainty. The usual mode of increasing plants, that mode which has been more especially provided by Nature, is by seeds; but, while seeds increase the species without error, the peculiarities of varieties can rarely be perpetuated in the same manner. In order to secure the multiplication of a variety, with all its qualities unaltered, it is necessary that portions should be detached from the original individual, and converted into new individuals, each to undergo a similar dismemberment, with similar consequences. It happens that while in animals this is impracticable, except in the case of polypes, the system of life in a plant is, of all others, the best adapted to such a purpose. We are accustomed to consider individual plants of exactly the same nature as individual animals; this, however, is a vulgar error, which is dissipated by the slightest inquiry into the nature of a plant. A plant is really an animated body, composed of infinite multitudes of systems of life; all, indeed, united in a whole, but each having an independent existence. When, therefore, any number of these systems of life is removed, those which remain, as well as those which are separated, will, under fitting circumstances, continue to perform their natural functions as well as if no union between them had ever existed. These systems of life are buds, each having a power of emitting descending fibres in the form of roots, and also of ascending in the form of stem. The first of these buds is the embryo; the others are subsequently formed on the stem emitted by the embryo. As these secondary buds develop, their descending roots combine and form the wood; their ascending stems give rise again to new buds. These buds are all exactly like each other; they have the same constitution, the same

organic structure, and the individuals they are capable of producing are, consequently, all identically the same; allowance, of course, being made for such accidental injuries or alterations as they may sustain during their subsequent growth. It is upon the existence of such a remarkable physiological peculiarity in plants, that propagation entirely depends; an evident proof of which may be seen in this circumstance: take a cutting of a vine, consisting only of the space which lies between two buds, or an internodium, as botanists would call such a piece, and no art will succeed in ever making it become a new plant, no matter how considerable the size of the internodium may be.* But, on the other hand, take the bud of a vine without any portion of the stem adhering to it, and it will throw out stem and root, and become a new plant immediately. If we examine the various modes employed in horticulture for propagating plants, we shall find that, however different they may be in appearance, they all consist in the application of these principles under various forms. It will be most convenient to consider these methods separately.

Propagation is effected by the arts of increasing by eyes, striking from cuttings, layering, budding, and grafting.

Increasing by eyes is the simplest of all these methods. It consists in nothing but extracting a single system of life, or a bud, from a given plant, placing it in due heat and moisture, and surrounding it with fitting food, thus causing it to grow as a solitary individual, instead of as one of the community to which it originally belonged.

Striking from cuttings is a slight modification of the last method. Instead of taking a single bud, a stem, containing two, three, or more buds, is placed in circumstances fitted for the maintenance of its life. In this case, the chances of success are increased by the additional number of buds which are the subject of experiment. That bud which is nearest the bottom of the cutting emits its roots at once into the earth, and so establishes a communication between the general system of the cutting and the medium from which its food is to be derived. The other buds, by pushing their stems upwards into light, attract the nutriment absorbed by the roots, and so stimulate the latter to increased action. Ultimately, the roots of all the buds descend between the bark and the wood until they reach the earth, into which they finally pass, like those of the first bud. There is another circumstance which renders the operation of striking plants from cuttings less precarious than from eyes. In both cases, the buds have, at the outset, to feed upon matter in their vicinity, until they shall have formed roots which are capable of absorbing food from the earth; but in eyes, the nutritive matter can only exist in such portions of the stem as may have been cut away with themselves; while, on the other hand, in cuttings, the stem itself forms an important reservoir of nutriment. This is a consideration, the practical importance of which will be obvious to every cultivator. As it is from the buds alone of cuttings that roots proceed, it follows, that in cases

* This is, of course, said without reference to the power which some plants possess of developing latent buds; a subject which is foreign to the present inquiry.

of difficulty, when plants strike unwillingly, anything which may facilitate the immediate introduction of roots into the soil will be advantageous. It is for this reason that a good operator always takes care that the lower end of his cutting is pared down as close to the base of a bud as may be practicable without actually destroying any part of the bud itself; by this means, the first emitted roots, instead of having to find their way downwards between the bark and wood, strike at once into the earth, and become a natural channel by which nutriment is conveyed into the general system of the cutting.

Layering is nothing but striking from cuttings that are still allowed to maintain their connection with the mother plant by means of a portion at least of their stem. Where roots are emitted with great readiness, simply bending a branch into the soil, leaving its point above ground, is sufficient to insure the success of the operation; but in cases of difficulty, other expedients are resorted to, all which will still be found to have reference to the emission of roots by buds. A common practice is, to head down the branch that is laid into the earth; this is to call into action the buds below the incision, by stopping the general axis of development. Another method is, to "tongue" the layer, that is, to split the stem just up to the origin of a bud—a practice that has the effect of enabling the roots to be emitted into the soil through the wound more readily than if they had to pierce through the bark; the resistance offered to their passage through the bark is in many cases so great as to compel them to continue to make wood, rather than to appear in the form that is necessary for the success of the cultivator.

Budding and grafting are operations that equally depend for their success upon the property that buds possess of shooting roots downwards and stems upwards; but in these practices, the roots strike between the bark and wood of the stock, instead of into the earth, and form new layers of wood, instead of subterranean fibres. The success of such practices, however, depends upon other causes than those which influence the growth of cuttings. It is necessary that an adhesion should take place between the scion and the stock, so that when the descending fibres of the buds shall have fixed themselves upon the wood of the stock, they may not be liable to subsequent separation. No one can have studied the economy of the vegetable kingdom without having remarked that there is a strong tendency to cohesion in bodies or parts that are placed in contact with each other. Two stems are tied together for some purpose: when the ligature is removed, they are found to have grown into one; two cucumbers accidentally placed side by side, or two apples growing in contact with each other, form double cucumbers or double apples; and most of the normal modifications of the leaves, floral envelopes, or fertilizing organs, are due to various degrees of cohesion in contiguous parts. This cohesion will be always found to take place in the cellular tissue only, and never in the vascular tissue. In the stems of all such trees as are grafted by orchardists, the cellular tissue is found alive only in the medullary rays and the liber; it is therefore essential, in the first place, that those parts, both in the

stock and the scion, should be placed in contact. In regard to the medullary rays, these are so numerous and so closely placed that it is scarcely possible that a portion of one stem should be applied to another without the medullary rays of both touching each other at many points. No care, therefore, is required to insure this, which may be safely left to chance. But in regard to the liber, as this is confined to a narrow strip both in stock and scion, great care must be taken that they are both placed as exactly in contact with each other as possible, so that the line of separation of the wood and bark should, in both stock and scion, be accurately adjusted. The success of grafting depends very much upon attention to this. But there are other reasons why this accuracy in adjusting the line between the bark and wood of the stock and scion is so important. It is at that part that the roots of the latter pass downwards over the former; and it is also there that the substance called "cambium," which serves as food for the young descending fibres, is secreted. It is obvious that the more accurate the adjustment of the line separating the wood from the bark, the more ready will be the transmission of young fibres from the one to the other; and that the less the accuracy that may be observed in this respect, the greater the difficulty of such transmission will be. Provided the stock and scion be of exactly the same size, the adjustment can scarcely fail to be accurate in the most unskillful hands; it is in the more common case of the scion being much smaller than the stock that this is to be most particularly attended to.

Budding differs from grafting in this: that a portion of a stem is not made to strike root on another stem, but that, on the contrary, a bud deprived of all trace of the woody part of a stem is introduced beneath the bark of the stock, and there induced to strike root. In this operation, no care is requisite in securing the exact contact of similar parts, and a free channel for the transmission of the roots of the bud between the bark and wood of the stock; for, from the very nature of the operation of budding, this must of necessity be insured. The bark of the bud readily coheres with the wood of the stock, and secures the bud itself against all accident or injury. But if precautions of the same nature as in grafting are not requisite in budding, others are of no less moment. It is indispensable that the bud which is employed should be fully formed, or what gardeners call ripe; if it is imperfectly formed, or unripe, it may not be capable of that subsequent elongation upwards and downwards, upon which the whole success of the practice depends. Secondly, great care should be taken, in raising the bark of the stock for the insertion of the bud, that the cambium be not injured or disturbed. The cambium is a secretion between the wood and bark, not only destined to support the descending fibres of the buds, but also to generate the new cellular substance within which the descending fibres are finally found imbedded. If, in the preparation of the bark for receiving the bud, this cambium be injured or disturbed, it becomes much less capable of effecting the cohesion that is necessary, than if uninjured. In budding, therefore, the bark should be carefully "lifted up," and not forced from the

wood with a bone or metallic blade, as is usually the case; for, although it is no doubt true that an operation clumsily performed will often succeed, yet it should be remembered that, if skillfully managed, it would be attended with much better success, and that a habit of constantly operating with delicacy will enable a gardener to succeed with certainty, in cases in which a bungling practitioner would be sure to fail. Little do those who crush with rude hands the tender limbs of plants reflect how delicate is that organization upon which the life of their victim is dependent.

Transplanting, perhaps, is that operation in which the greatest difficulty is generally found to exist, and in which the causes of failure or success are often the least understood. Volumes have been written upon the subject, and the whole range of vegetable physiology has been called in aid of the explanation of the theory; yet I am much mistaken if it cannot be proved to depend exclusively upon the two following circumstances: first, by the preservation of the spongioles of the roots; secondly, by the prevention of excessive evaporation.

It is well known that plants feed upon fluids contained in the soil, and that their roots are the mouths through which the food is conveyed into their body. But the absorption of fluid does not take place either by all the surface of their roots, nor even of their fibres, but only by the extremities of the latter, consisting of bundles of vessels surrounded by cellular tissue, in a very lax, spongy state; whence those extremities are called spongioles. That it is only through the spongioles that absorption to any amount takes place, is easily shown by growing a plant in water, and alternately preventing the action of the spongioles, when langour and a cessation of vital action comes on, and preventing the action of the general surface of the roots, leaving the spongioles at liberty, when the vital energies are immediately renewed. These spongioles are exceedingly delicate in their organization, and a very slight degree of violence destroys them. It is scarcely possible to remove the soil from the roots without injuring them in some degree; and if transplantation is effected violently or carelessly, they are in a great measure destroyed. In proportion to the size or age of a tree, is the difficulty of preserving them increased; and hence, at the same time, the difficulty of transplantation is augmented. If, by any method, the spongioles could be preserved unharmed, there would be no reason whatever why the largest forest tree should not be removed as easily as the young plants in a nursery; but their preservation in such cases is impracticable, and therefore the transplantation of trees of great magnitude cannot be effected. It is because of the security of the spongioles from injury when the earth is undisturbed, that plants reared in pots are transplanted with so much more success than if taken immediately from the soil. Hence, also, when earth is frozen into a huge ball around the root of a plant, transplantation is effected with the same kind of certainty. The practice of cutting the roots of large trees the year previous to removing them is attended with success for a similar reason. Wherever the roots are cut through, the new fibres which are emitted, provided a plant is in health, in short tufts, and

each terminated by a spongiole, are much more easily taken out of the ground without injury than if they were longer and more scattered among the soil. When destroyed, the spongioles are often speedily replaced, particularly in orchard trees, provided a slight degree of growth continues to be maintained. This is one of the reasons why trees removed in autumn succeed better than if transplanted at any other time. The growth of a tree, at that season, is not quite over; and the first impulse of Nature, when the tree finds itself in a new situation, is to create new mouths by which to feed when the season for growing again returns.

Evaporation takes place in plants to an inconceivable degree under certain circumstances. It is known, by the experiments of Dr. Hales, that a sun-flower plant will lose as much as 1 pound 14 ounces by perspiration in twelve hours; and that in general, "in equal surfaces and equal times, a man would perspire one-fiftieth, the plant one-one hundred and sixty-fifth, or as 50 is to 15;" and that, taking all things into account, a sun-flower perspires seventeen times more than a man. The same most accurate observer found that a cabbage perspired in twelve hours 1 pound 9 ounces; a Paradise stock in a pot, 11 ounces; and a lemon plant, 8 ounces. Guettard states that he found a Cornus mascula perspire twice its own weight in a day; and Mr. Knight has remarked a vine in a hot day losing moisture with such rapidity that a glass placed under one of its leaves was speedily covered with dew, and in half an hour the perspiration was running off the glass. In damp or wet weather, this evaporation is least; in hot, dry weather, it is greatest. This loss has all to be supplied by the moisture introduced into the system by the spongioles; and hence, if the spongioles are destroyed, and evaporation takes place before they can be replaced, a plant must necessarily die. This is the reason why deciduous trees cannot be transplanted when in leaf; it is difficult to remove them without injuring their spongioles, and it is equally difficult to hinder the evaporation by their leaves; but if they are kept in pots, it matters not at what season their removal takes place, because, as their spongioles are then uninjured, even excessive evaporation would be made good by their action. It is well known that certain evergreens, such as hollies, laurels, &c., can be transplanted in almost all months; this arises from their perspiration being much less copious than in deciduous-leaved trees, wherefore the spongioles have less difficulty in supplying the loss occasioned by it; yet even evergreens cannot well be removed in the hottest months in the year, because then, the action of such spongioles as may be saved in the operation would not be sufficient to supply the waste by evaporation. Plants first beginning to grow in the spring, with their leaves just turning green, are in a most unfit state to remove; for, when transplanted, their roots will not have time to form a sufficient number of new spongioles to supply the loss to which the rapid perspiration by the leaves at that season will give rise. It is upon this same principle that, if deciduous plants are taken from the ground in the summer, they are put into pots and placed in a hot-bed to recover, not for the sake of the heat, but because the atmosphere of a hot-bed is so charged with

humidity, that perspiration cannot go on, so that the vital energies of the plant, instead of being wasted by evaporation, are directed to the formation of new mouths by which to feed.

This is but a brief outline of what the principles are upon which the common operations of the fruit-garden depend; yet it is hoped that it may not be without its use in calling attention to the rationale of what may seem extremely simple and well-understood practices, but which are undoubtedly neither so perfect, nor generally so skillfully performed, as to be incapable of amendment. D. J. B.

VITALITY AND GERMINATION OF SEEDS.

[Condensed from the Gardener's Chronicle, London]

No subject of vegetable physiology is more interesting, both for theoretical and practical reasons, than the power which seeds undoubtedly possess, under certain circumstances, of preserving their vitality for an apparently indefinite period. It is doubtless true that many of the statements on this subject, to be found in books, are apochryphal; but, certainly, some are founded on fact. None among the so-called instances of this excessive longevity have excited more doubt and discussion than what is called "mummy wheat;" that is to say, wheat taken from mummies, and therefore of the highest antiquity, which has grown when sown. We have never succeeded in satisfying ourselves, however, that the seeds from which such wheat is said to have been produced was really taken from mummy-cases. There is always some defect in the evidence. All such statements may be true, but there is no proof that they are so; and when we are told that onions taken from similar receptacles have also grown—*which is impossible*—we may be pardoned for requiring very decisive evidence before we accord our belief in those prodigies. The history of this wheat was given by Mr. Martin Farquhar Tupper, a most exact and conscientious man, in the "London Times," of September, 1840; and to that gentleman we are indebted for the additional facts which we are now able to communicate.

Sir Gardiner Wilkinson, when in the Thebaid, opened an ancient tomb (which had probably remained unvisited by man during the greater part of three thousand years,) and from *some alabaster sepulchral vases* therein took with *his own hands* a quantity of wheat and barley that had been there preserved. Portions of this grain were given to Mr. Pettigrew, who presented Mr. Tupper with twelve grains of the venerable harvest. In 1840, Mr. Tupper sowed these twelve grains, and, to show the care with which he preserved their identity, we shall quote his own account of his proceedings thereupon. "I ordered," he says, "four garden pots of well-sifted loam, and, not content with my gardener's care in sifting, I emptied each pot successively into an open newspaper, and put the earth back again, morsel by morsel, with my own fingers. It is next to impossible that any other seed should have been there. I then, (on the 7th of March,

1840) planted my grains, three in each pot, at the angles of an equilateral triangle, so as to be sure of the spots where the sprouts would probably come up, by way of additional security against any chance seed unseen lurking in the soil. Of the twelve, one only germinated, the blade first becoming visible on April 22d; the remaining eleven, after long patience, I picked out again, and found in every instance that they were rotting in the earth, being eaten away by a number of minute white worms. My interesting plant of wheat remained in the atmosphere of my usual sitting room until change of place and air seemed necessary for its health, when I had it carefully transplanted to the open flower-bed, where it has prospered ever since. The first ear began to be developed on the 5th of July; a second ear made its appearance, and both assumed a character somewhat different from all our known varieties. Their small size and weakness may, in one light, be regarded as collateral evidence of so great an age, for assuredly the energies of life would be but sluggish after having slept so long; however, the season of the sowing—spring instead of autumn—will furnish another sufficient cause. The two ears, on separate stalks, were, respectively, 2½ and 3 inches long, the former being much blighted, and the stalk about 3 feet in height."

"If, and I see no reason to disbelieve it," continues Mr. Tupper, "if this plant of wheat be, indeed, the product of a grain preserved since the time of the Pharaohs, we moderns may, within a little year, eat bread made of corn which Joseph might have reasonably thought to store in his granaries, and almost literally snatch a meal from the kneading-troughs of departing Israel."

Here we have no link lost in the chain of evidence. Sir Gardiner Wilkinson himself opened the tomb, and with his own hands emptied the alabaster vase; of its contents he gave a portion to Mr. Pettigrew, who gave it to Mr. Tupper, who himself sowed it, watched it, and reared it.

On the contrary, it is alleged that all the grain taken from the Egyptian urns are perfectly indurated, and possess every appearance of having been roasted. A correspondent says: "I remember, in 1814, to have seen in the hands of the celebrated Egyptian traveller and antiquary, Denon, at Paris, several specimens of wheat which he had extracted from urns found by him at Egyptian Thebes, when, as the head of a scientific body, he accompanied Bonaparte's expedition to Egypt. He told me that, immediately on his return to France, he had, in order to satisfy the curious, carefully tried every possible experiment with his discovered grains, by sowing some in autumn, some in spring, some in the open air, some in hot-houses, some steeped previously in water, the rest in its natural state, if that could be called natural which had a most unnatural appearance, having every show of having been calcined, of which fact M. Denon did not entertain any doubt. Be it observed that Denon did not try this experiment with the produce of one discovery, but of many. * * * I want to know who can prove the growth of any mummy-wheat in this country? Let us know all the circumstances. Who discovered it? What are the circumstances of the discovery? Where was it

made? When? The date is important. Let him account for it in the various hands through which it passed till it was deposited in the earth. Let him show us how it was secured against the possibility of fraud in every stage of its custody during this interval; how secured during the trial of the experiment; how many grains were sown; how sown; how long it was before they came up; how many came up; and, above all, I repeat, what security he had against the hoax of some mischievous person during this part of the experiment. It is nothing to show that he obtained a stem or ear of peculiar character, if the existence of that kind of ear was known before. All the mummy-wheat I have seen is of sorts common in Egypt at this day. Has any mummy-wheat been ever raised in Egypt? I believe none. But I have always understood that there is not in the world a cleverer fellow at bamboozling a traveller, and accommodating his tastes by the preparation of discoveries for him, than the Arab guide; that the Roman antiquarians, and the venders of antiquities, and the peasants of Pæstum, do not surpass him in intelligence of that sort. I beg to say, that I do not in the slightest degree question the strict probity and sincere convictions of those who have found or reared certain wheats to which they have given the name of mummy-wheat; but I do suspect that somewhere there is a mistake."

Mention is made of an ear of wheat having been exhibited at the Newcastle Farmers' Club, which was supposed to have been grown from seed found in an Egyptian mummy-case. Statements of the same general character have been put forth elsewhere. "I lately met with one," says a writer, "in the 'Botanical Rambles,' published under the direction of the Society for promoting Christian Knowledge. Two figures are there given of the kind of wheat alluded to, and an interesting and very marvellous inference is drawn from the presumed accuracy of the facts detailed. It is asserted that, in Egypt of old, it was no more uncommon to meet with seven ears of corn growing on one stalk than seven kine feeding together in one meadow! The variety has proved to be nothing more than an old and well-known kind of 'Revel wheat,' called 'Egyptian wheat,' and which I have occasionally seen cultivated in this neighborhood. I presume this variety has been so called in allusion to Pharaoh's dream, when he fancied he saw the anomalous fact of one stalk bearing seven ears. This variety does not, in reality, bear more ears than usual, namely, one only; but it has several of the spikelets so much elongated that they bear more grains than usual. It is this circumstance that gives it the appearance of a cluster compounded of several ears. It is a monstrosity which occasionally returns, under culture, to the more ordinary conditions of the ear; neither is it, when most prolific, considered to be a variety of any great value. Now, it is the mere name of this variety which has misled many to suppose it identical with the kind of wheat that was raised in the celebrated experiment recorded in the "Gardener's Chronicle" for 1843, but which is there stated to have been the 'Bellevue Talavera' of Colonel Le Couteur. I can fully confirm this, because I had six grains from the specimens raised by Mr. Tupper, and grew

them in company with several varieties of wheat in my garden. Among these, were plants of the 'Bellevue Talavera,' and I had ample opportunity of comparing them with the descendants of the 'mummy-wheat.' This variety was specially remarkable for exceeding in length of straw, and for flowering much earlier than any of the other varieties in my garden. In this, and in all other particulars, I could not observe the slightest difference between the Bellevue Talavera and the mummy-wheat; both, also, were attacked more vigorously than the rest by rust and mildew. If, then, the single seed reared by Mr. Tupper was really deposited in the catacombs during the time of the Pharaohs, the wheat of Egypt was not the existing Egyptian wheat, so far as this experiment may be considered decisive. But I have long suspected the possibility of a flaw in the testimony upon which this one grain is supposed to have been so old as Mr. Tupper and Sir G. Wilkinson believed it to be. Application was once made to the latter for specimens of mummy-wheat, in order that it might be tried among a series of experiments 'on the vitality of seeds,' which have been in progress for a few years, under the superintendence of a committee of the British Association. The person who had been requested to apply to this gentleman was furnished with a sample by himself. Upon his proceeding to share the grains among the parties experimenting, he was surprised to find them intermixed with grains of maize, a plant of the New World. This, of course, led to further inquiry, and the conclusion arrived at was, that the sample had most certainly been tampered with before it came into his possession. Without presuming to deny the possibility of mummy-wheat retaining its vital powers for three thousand years, I must consider the above fact, coupled with the strange misapprehension that has arisen respecting the mummy origin of our 'Egyptian wheat,' to throw an amount of suspicion upon the accuracy of the results which Mr. Tupper considered he had obtained, which makes it necessary the experiment should be repeated before we can feel satisfied that a grain of mummy-wheat has really germinated in our own times."

At a meeting of the British Association for the Advancement of Science, on the 15th of August, 1848, Dr. Daubeny said that he had recently heard of a well authenticated case of seeds from the inside of a mummy producing plants when sown; the only misfortune in this case was, that the seed produced maize. Now, maize was a plant of the New World, and, although grown in Egypt now, must have been introduced into the mummy since the discovery of America. All kinds of tricks were played with mummies, for the purpose of deceiving travellers. Mr. Babington stated that he had never yet seen a case of the supposed growth of mummy-wheat that would bear investigation, and he had the strongest impression that no such growth ever took place.

The above named Association, it will be remembered, appointed a committee, in 1841, to experiment on the growth and vitality of seeds, and issued a circular with the view of determining the following questions

1. What is the longest period during which the seeds of any plant, under any circumstances, can retain their vegetative power?

2. What is the extent of this period in each of the natural orders, genera, and species of plants, and how far is it a *distinctive* character in such groups?

3. How far is the extent of this period dependent on the apparent characters of the seed, such as size, hardness of covering, hardness of internal substance, oiliness, mucilage, &c.?

4. What are the circumstances of situation, temperature, dryness, seclusion from the atmosphere, &c., most favorable to the preservation of seeds?

Botanists and others were invited to make the following series of experiments, and to communicate the results to the Association:

Retrospective Experiments.—First. By collecting samples of ancient soils from situations where vegetation cannot now take place, and by exposing these soils to air, light, warmth, and moisture, to ascertain whether any, and, if any, what species of plants spontaneously vegetate in them.

Care must, of course, be taken that no seeds obtain admittance into these soils from external sources, such as the air or water introduced to promote vegetation. These ancient soils are either natural or artificial deposits. The *natural* deposits are either of *past* geological periods, or of the *recent* period.

The deposits of past periods are either secondary or tertiary.

There is every possible reason to believe that the age even of the latest of these deposits is far beyond the maximum period through which vegetative powers can be preserved; yet, as many accounts are recorded of seeds vegetating spontaneously in such soils, it would be well to set these statements at rest by actual experiment. In such experiments, state the formation, and describe the geological phenomena of the locality, with the depth from the present surface at which the soil was obtained.

Natural deposits of the recent period may be classed as follows: Alluvions of rivers, tidal warp-land, shell-marl, peat, surface-soil buried by landslips, surface-soil buried by volcanic eruptions. In these cases, state the nature of the soil, the depth of the surface, &c.; and especially endeavor to obtain an approximate date to each specimen of soil, by comparing its depth from the surface with the present rate of deposition, or by consulting historical records. It would be well to submit to experiment a series of samples of soil from successive depths at the same locality.

Artificial deposits are as follows: Ancient tumuli; ancient encampments; the soil beneath the foundations of buildings; the soil with which graves, wells, mines, or other excavations have been filled up; ridges of arable land, &c. In these cases, state, as before, the depth from the surface, and ascertain from historical sources the approximate age of the deposit.

Second. By trying experiments on actual seeds which exist in artificial repositories. These are—seeds in old herbaria and botanical museums; seeds obtained from mummies, funereal urns, Pompeii,

Herculaneum, &c.; dated samples of old seeds from nurserymen and seedsmen. In these cases, state the circumstances in which the seeds have been preserved, and their date as nearly as it can be ascertained.

Prospective Experiments.—In this mode of experimenting, it is proposed to form deposits of various kinds of seeds under different conditions, and to place a portion of them at successive periods in circumstances calculated to excite the process of vegetation. In the case of certain species or families of plants, it would, perhaps, require many centuries to determine the limit of their powers of vegetation; yet it is probable that a very few years would suffice to fix the maximum duration of the greater number, and many interesting results might thus be obtained even by the present generation of botanists. It is proposed, then, to form a collection of seeds of a great variety of plants, (including, as far as possible, at least one species of every genus,) and to pack them up (carefully labelled) either alone, or mixed with various materials, as sand, sawdust, melted wax or tallow, clay, garden mould, &c., in various vessels, as glass bottles, porous earthen jars, wooden boxes, metallic cases, &c., placed in various situations, as under ground, in cellars, dry apartments, &c. At certain intervals, increasing in extent, say at first every two years, then every five, every ten, and at the lapse of a century, every twenty years, a small number (say twenty) of each kind of seed, from each combination of circumstances, to be taken out and sown in an appropriate soil and temperature, and an exact register kept of the number of seeds which vegetate compared with those which fail. In this manner, it is believed that, in regard to the large majority of plants, the limit of their vegetative durability would be determined in a very few years, and a large mass of vulgar errors on this subject, which now pass current for facts, would be cancelled and exploded.

The most effectual way of exciting vegetation in seeds of great antiquity is to sow them in a hot-bed, under glass, and in a light soil moderately watered.

The annexed table gives a general summary of the experiments as above, from 1841 to 1850, inclusive.

General summary of the experiments from 1841 *to* 1850, *inclusive.*

NAMES.	Years old.	No. of seeds sown.	No. of seeds germinated.
GRAMINACEÆ.			
1. Zea mays, Indian corn	3	300	127
Cobbett's corn	2	27	12
2. Phalaris canariensis, Canary seed	3	300	147
Do do	8	200	19
Do do	9	----	nil.
3. Panicum miliaceum, millet	2	400	178
Do do	3	200	100
4. Avena sativa, oat	3	300	237
Do	8	200	37
Do	9	----	nil.
Do	3	*300	210
5. Triticum æstivum, wheat	3	300	163
Do do	8	----	nil.
Do do	9	----	nil.
Do do	3	*300	139
Do do	3	†300	140
Triticum, sp. mummy-wheat	?	----	nil.
6. Secale cereale, rye	3	600	4
7. Hordeum vulgare, barley	3	300	167
Do do	8	----	nil.
Do do	9	----	nil.
Do do	3	††300	236
Do do	48	----	nil.
Do do	50	----	nil.
PALMACEÆ.			
8. Phœnix dactylifera, date	3	----	5
Do do	8	----	nil.
AMARYLLIDACEÆ.			
9. Alstrœmeria pelegrina	3	60	5
Do do	8	----	nil.
Alstrœmeria aurantiaca	3	----	nil.
IRIDACEÆ.			
10. Sisyrinchium bermudianum	2	100	1
11. Iris sibirica	3	150	14
Do	8	----	----
Iris, sp	3	75	4
12. Tigridia pavonia	3	300	36
13. Gladiolus psittacinus	3	300	17
Do do	8	----	----
LILIACEÆ.			
14. Allium fragrans	3	300	98
Do	5	----	nil.
Do	10	450	2
Allium senescens	4	60	3
15. Camassia esculenta, camass	5	----	nil.

* Preserved (in waxed cloth). † Preserved (in open jar). †† Preserved (in waxed cloth).

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
Camassia esculenta, camass	10	300	1
16. Ornithogalum pyrenaicum	6	----	----
17. Asphodelus luteus	3	150	32
18. Asparagus officinalis, asparagus	3	450	97
Pinaceæ.			
19. Pinus pinea, stone pine	12	19	3
20. Juniperus communis, juniper	3	----	nil.
Do do	8	----	----
Betulaceæ.			
21. Betula alba, birch	3	----	nil.
22. Alnus glutinosa, alder	3	----	nil.
Cannabinaceæ.			
23. Cannabis sativa, hemp	3	----	nil.
Do do	8	100	13
Do do	9	----	nil.
Moraceæ.			
24. Morus nigra, black mulberry	3	300	59
Do do	8	----	----
Euphorbiaceæ.			
25. Euphorbia lathyris	3	150	46
Do do	7	----	nil.
26. Croton, sp	21	50	30
27. Ricinus communis, castor-bean	3	45	15
Do do	8	----	----
Corylaceæ.			
28. Fagus sylvatica, beech	3	----	nil.
29. Carpinus betula, hornbean	3	----	nil.
30. Quercus robur, English oak	3	30	3
Do do	8	----	----
Cucurbitaceæ.			
31. Momordica elaterium	3	75	13
Do do	8	----	----
32. Cucurbita cucuzza	14	40	29
Mellone di Spagna	13	20	11
Green Egyptian melon	14	40	3
Marari	14	29	8
Mellone di acqua	13	90	8
Mellone di pane bianca	13	50	2
Valencia melon	12	50	20
Early cantaloupe melon	10	72	50
Melon from Lisbon	10	20	11
Melon	9	150	50
Melon from Cassabar	8	15	11
Memoja	10	5	4

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
Cucurbita, sp	3	45	37
Do	8	45	19
33. Bryonia dioica	3	300	5
PASSIFLORACEÆ.			
34. Passiflora herbertiana	8	------------	nil.
35. Tacsonia pinnatistipula	6	------------	nil.
VIOLACEÆ.			
36. Viola lutea	3	450	99
CRUCIFERÆ.			
37. Matthiola annua, ten-weeks' stock	3	600	236
38. Cheiranthus, sp., wall flower	3	80	38
39. Turritis retrofracta	6	------------	nil.
40. Arabis hirsuta	3	200	36
Arabis lucida	8	------------	nil.
41. Koniga maritima	3	600	170
42. Lunaria biennis	3	300	114
43. Vesicaria grandiflora	3	------------	nil.
44. Iberis umbellata	3	100	11
Do	3	200	150
Do	8	------------	------------
45. Biscutella erigerifolia	3	300	71
46. Malcomia maritima	3	300	178
Do	8	------------	nil.
47. Hesperis matronalis	3	300	66
48. Erysimum peroffskianum	3	300	82
Do do	8	------------	------------
49. Lepidium sativum, cress	3	300	195
Do do	8	200	19
Do do	9	100	1
50. Ethionema saxatile	3	100	15
51. Isatis tinctoria, woad	4	100	15
52. Brassica napus, rape	3	450	323
Do do	8	300	4
Do do	9	------------	nil.
Brassica rapa, turnip	3	900	335
Do do	8	600	15
Do do	9	300	5
Brassica rapa oleifera, turnip-rape	4	100	85
Brassica oleracea, cabbage	3	150	11
Do do	3	*150	40
Do do	8	------------	nil.
Do do	9	------------	nil.
53. Diplotaxis tenuifolia	3	300	4
54. Crambe maritima, sea-kale	3	300	6
55. Bunias orientalis	3	100	57
Do do	4	50	2
56. Heliophila araboides	3	600	165
57. Schizopetalon Walkeri	3	150	30
CAPPARIDACEÆ.			
58. Cleome spinosa	3	300	61

* In waxed cloth.

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
Byttneriaceæ.			
59. Hermannia, sp.	4	150	1
Tropæolaceæ.			
60. Tropæolum majus, nasturtium	3	75	52
Do do	8	----------	nil.
Tropæolum peregrinum	2	30	15
61. Limnanthes Douglasii	3	----------	nil.
Malvaceæ.			
62. Malope grandiflora	3	300	127
Do do	8	300	10
63. Kitaibelia vitifolia	4	200	23
64. Lavatera trimestris	2	100	50
65. Malva mauritiana	3	600	281
Malva moschata	4	100	18
Malva, sp.	10	80	6
Do do	25	100	17
66. Hibiscus, sp	27	100	3
67. Gossypium, sp. cotton	4	8	2
68. Sida, sp.	25	150	75
Tiliaceæ.			
69. Corchorus, sp.	27	50	2
70. Triumfetta, sp.	25	75	30
Hypericaceæ.			
71. Hypericum hirsutum	3	450	94
Hypericum kalmianum	8	----------	nil.
Magnoliaceæ.			
72. Magnolia, sp.	3	45	4
Do	8	----------	nil.
73. Liriodendron tulipifera, tulip tree	3	----------	nil.
Do do do	8	----------	nil.
Ranunculaceæ.			
74. Clematis erecta	6	----------	nil.
75. Thalictrum minus	3	----------	nil.
Do do	4	----------	nil.
76. Anemone coronaria	3	----------	nil.
Do do	4	----------	nil.
77. Adonis autumnalis	3	150	79
Do do	8	150	7
78. Ranunculus caucasicus	3	----------	nil.
Do do	4	----------	nil.
79. Nigella nana	3	150	40
Do	8	----------	nil.
80. Aquilegia sibirica	6	----------	nil.
81. Helleborus fœtidus, hellebore	3	----------	nil.
82. Delphinium intermedium	4	----------	nil.

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
Delphinium flexuosum	5		nil.
Do ....do	10		nil.
Delphinium, sp	6	200	1
83. Aconitum napellus	3	300	13
Do ....do	8		nil.
84. Pæonia, mixed vars.	3		
Do ....do	8		nil.
Do ....do	9		nil.
PAPAVERACEÆ.			
85. Argemone alba	3	300	159
Argemone grandiflora	3		nil.
86. Papaver somniferum, opium poppy	5	150	73
Papaver orientale, oriental poppy	5		nil.
Papaver amœnum	3	300	47
Do ....do	8		nil.
87. Glaucium rubrum	3	300	47
Do ....do	8		nil.
88. Eschscholtzia californica	3	600	124
89. Chryseis crocea	5	100	4
Do ....do	10		nil.
FUMARIACEÆ.			
90. Hypecoum procumbens	6		nil.
Do ....do	7		nil.
91. Fumaria spicata	3	300	5
BERBERIDACEÆ.			
92. Mahonia aquifolia	7		nil.
ANACARDIACEÆ.			
93. Rhus, sp	4	50	7
XANTHOXYLACEÆ.			
94. Ailantus glandulosa, ailantus	3	150	3
LINACEÆ.			
95. Linum perenne, perennial flax	2	100	16
Linum usitatissimum, common flax	3	200	56
Do ....do ....do	3	450	202
Do ....do ....do	8	300	18
Do ....do ....do	9		nil.
BALSAMINACEÆ.			
96. Balsamina hortensis	6	150	81
97. Impatiens glanduligera	3	150	34
Do ....do	8	150	11
GERANIACEÆ.			
98 Pelargonium, sp	4	62	15

General summary of the experiments—Continued.

NAMES.	Years old.	No. of seeds sown.	No. of seeds germinated.
CARYOPHYLLACEÆ.			
99. Buffonia annua	3	300	16
Do do	8		nil.
100. Dianthus barbatus, Sweet William	3	300	181
Dianthus chinensis, China pink	3	150	62
101. Saponaria annua	3	450	38
102. Gypsophila elegans	3	600	143
Do do	7	500	1
103. Silene quadridentata	2	100	31
Silene pendula	2	200	41
Silene inflata	3	150	88
Silene armeria alba	3	100	31
104. Viscaria oculata	3	450	22
105. Pharnaceum, sp.	4	100	3
PORTULACACEÆ.			
106. Talinum ciliatum	3	600	188
107. Calandrinia grandiflora	4		nil.
Do do	5	200	39
Do do	10		nil.
Calandrinia speciosa	3	300	171
Do do	8	100	18
POLYGONACEÆ.			
108. Polygonum fagopyrum, buckwheat	3	150	25
Do do do	8	100	7
Do do do	9		nil.
109. Rumex obtusifolium	3	450	162
Rumex, sp	5	30	13
NYCTAGINACEÆ.			
110. Mirabilis jalapa, marvel of Peru	3	300	30
Do do do	8		nil.
PHYTOLACCACEÆ.			
111. Phytolacca decandra, poke-berry	3	75	21
AMARANTACEÆ.			
112. Amaranthus caudatus	3	300	178
Do do	8	300	1
CHENOPODIACEÆ.			
113. Chenopodium botrys	2		nil.
Do do	3		nil.
Chenopodium quinoa	2	400	171
Do do	3	200	14
114. Beta vulgaris, beet	3	225	155
SAURURACEÆ.			
115. Saururus, sp	4	50	2

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
MESEMBRYACEÆ.			
116. Mesembryanthemum crystallinum	3	300	94
Do do	8	300	112
TETRAGONIACEÆ.			
117. Tetragonia expansa, New Zealand spinach	3	45	22
Do do do	8		nil.
PROTEACEÆ.			
118. Leucadendron, sp	4	75	19
LEGUMINOSÆ.			
119. Podalyria, sp	4	150	113
120. Pultenæa, sp	21	100	2
121. Lupinus succulentus	3	300	85
Do do	8		nil.
Lupinus rivularis	5	25	1
Do do	10		nil.
Lupinus grandifolius	5		nil.
Do do	10	300	1
Lupinus polyphyllus	6	100	1
Lupinus lucidus	10		nil.
122. Crotalaria, sp	27	50	4
123. Aspalathus, sp	4	25	1
124. Ulex europæa, furze	3	300	113
Do do	8	300	27
125. Spartium scoparium	3	600	38
126. Cytisus albus	3	300	24
Cytisus laburnum	3	150	21
Do do	8	150	2
127. Tetragonolobus purpureus	3	75	40
Do do	8		nil.
128. Trifolium repens, white clover	3	450	22
Trifolium giganticum	3	100	38
Trifolium, sp	8		nil.
Do	9	150	5
129. Melilotus cærulea	3	300	149
Melilotus leucantha	3	100	60
Melilotus macrorhiza	4	100	36
Do do	7	500	180
Do do	8	250	69
130. Trigonella fœnum-græcum, fœnugreek	3	150	89
Do do	8		nil.
131. Medicago maculata	3	300	71
Do do	8	300	113
132. Ononis angustifolium	6	100	1
133. Indigofera, sp., indigo	4	175	28
134. Psoralea bituminosa	3	100	46
Do do	4	50	7
Psoralea, sp	4	200	107
135. Galega sibirica	10	110	9
Galega, sp	26	100	16
136. Sutherlandia, sp	4	100	5
137. Colutea, sp	43	75	1

General summary of the experiments—Continued.

NAMES.	Years old.	No. of seeds sown.	No. of seeds germinated.
138. Pisum sativum, garden pea	3	150	94
Do do	8	100	15
Do do	9		nil.
Fullard's German marrow fat	5	4	4
Do do do	3	150	100
Pisum, sp	7	50	36
139. Ervum, sp	4	100	90
140. Vicia sativa, vetch	3	150	87
Do do	4	100	82
Do do	8	100	8
Do do	9		nil.
Do do	3	*150	115
Vicia lutea, vetch	3	100	27
Do do	4	100	91
Vicia grandiflora	3	25	18
Do do	5	150	70
141. Faba vulgaris, Windsor bean	3	75	71
Do do	8	50	40
Do do	9	25	14
Augusta beans	7	50	24
Do do	3	30	30
Do do	2	5	5
Canada beans	6	50	42
Do do	5	16	16
142. Lathyrus annuus	2	25	21
Lathyrus sativus	3	6	6
Lathyrus heterophyllus	3	150	105
Do do	8	150	63
143. Orobus niger	3	150	18
Do	8	150	12
144. Scorpiurus sulcatus	3	75	22
Do do	8		
145. Coronilla, sp	42	25	17
146. Æschynomene, sp	26	100	28
Do do	27	100	1
147. Hallia, sp	4	25	14
148. Hedysarum, sp	26	100	3
Do do	27	200	9
149. Clitoria, sp	26	20	2
150. Erythrina, sp	4	3	1
151. Phaseolus multiflorus, kidney-beans	3	75	47
Do do do	8	50	1
Do do do	9		nil.
Phaseolus, sp	25	25	25
152. Dolichos lignosus	3	75	61
Do do	8	75	25
Dolichos, sp	27	5	2
Do do	8	50	36
153. Cæsalpinia, sp	27	6	2
154. Cassia canarina	10	10	1
Cassia, sp	26	120	86
Do do	8	20	4
155. Tamarindus, sp., tamarind	25	3	1
156. Cercis canadensis, red-bud	3	150	4
Do do	8		nil.
157. Gleditschia triacanthos, honey-locust	3		nil.

* In waxed cloth.

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
158. Mimosa, sp	4	42	5
159. Adenanthera, sp	25	6	4
160. Robinia pseud-acacia, white locust	3	300	30
Do do do	8		nil.
POMACEÆ.			
161. Cotoneaster rotundifolia	3	60	16
Do do	8		nil.
162. Cratægus macracantha	3	150	4
Do do	8		nil.
Cratægus punctata	3	150	3
Do do	8		nil.
ROSACEÆ.			
163. Potentilla nepalensis	3	300	52
Do do	7		nil.
Do do	8		nil.
Potentilla, sp	6		nil.
164. Geum, sp	5		nil.
Do do	10	1,500	3
LYTHRACEÆ.			
165. Cuphea procumbens	3	150	45
Do do	8		nil.
RHAMNACEÆ.			
166. Trichocephalum, sp	4	25	2
167. Phylica, sp	4	42	1
168. Cryptandra, sp	21	50	9
AQUIFOLIACEÆ			
169. Ilex aquifolium, holly	3		nil.
Do do do	8		nil.
SOLANACEÆ.			
170. Petunia odorata	3		nil.
171. Datura stramonium, Jamestown weed		300	109
Do do do	6	50	20
Do do do	8	200	30
Do do do	9		nil.
172. Hyoscyamus niger	3	300	7
Do do	8	300	4
173. Nicandra physaloides	3	300	143
Do do	8	300	142
174. Capsicum, sp	3	75	33
Do do	8		nil.
175. Solanum ovigerum, egg-plant	3		nil.
176. Lycopersicum esculentum, tomato	9	100	76
ASCLEPIADACEÆ.			
177. Asclepias verticillata	2	73	31

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
CONVOLVULACEÆ.			
178. Convolvulus major, morning glory	3	150	41
POLEMONIACEÆ.			
179. Collomia coccinea	3	300	64
Do do	8	----------	nil.
180. Gilia achilleæfolia	3	300	69
Do	3	600	214
Do	8	400	1
Do	8	----------	nil.
Do	9	----------	nil.
Gilia capita	7	----------	nil.
181. Leptosiphon androsacea	3	600	121
182. Polemonium cæruleum	3	300	78
Polemonium gracile	7	----------	nil.
183. Cobæa scandens	3	18	3
Do	8	----------	nil.
HYDROPHYLLACEÆ.			
184. Nemophila atomaria	2	200	62
185. Eutoca viscida	3	300	84
Do	8	----------	nil.
186. Phacelia tanacetifolia	3	300	122
Do do	4	150	50
Do do	8	----------	nil.
PLANTAGINACEÆ.			
187. Plantago media	3	450	130
Plantago cynops	3	----------	nil.
PRIMULACEÆ.			
188. Androsace macrocarpa	3	----------	nil.
189 Anagallis arvensis	3	300	89
Do do	8	300	158
NOLANACEÆ.			
190. Nolana atriplicifolia	3	300	150
Do do	8	----------	nil.
BORAGINACEÆ.			
191. Cerinthe major	3	150	70
Do	8	----------	nil.
192. Echium grandiflorum	3	300	135
193. Amsinkia angustifolia	2	100	3
194. Cynoglossum glochidatum	3	300	45
Do do	8	----------	nil.
LABIATÆ.			
195. Elsholtzia cristata	3	300	44
Do do	8	----------	nil.

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
196. Horminum pyrenaicum	7	....	nil.
197. Nepeta citriodora	2	100	3
Nepeta cataria	3	300	43
Do	8	300	2
198. Dracocephalum denticulatum	3	260	24
199. Leonurus cardiaca	3	300	78
Do.....do	8	300	5
200. Betonica hirsuta	3	....	nil.
Do	4	....	nil.
Verbenaceæ.			
201. Verbena aubletia	3	....	nil.
Selaginaceæ.			
202. Hebenstreitia tenuifolia	3	300	102
Pedaliaceæ.			
203. Martynia proboscidea	3	60	10
Do.....do	8	....	nil.
Bignoniaceæ.			
204. Eccremocarpus scaber	3	300	3
205. Catalpa cordifolia, catalpa	3	....	nil.
Scrophulariaceæ.			
206. Browallia elata	3	150	6
207. Schizanthus pinnatus	3	600	240
208. Verbascum thapsus	3	1,500	126
Do.....do	8	....	nil.
Do.....do	9	....	nil.
209. Alonsoa incisa	3	300	5
210. Linaria bipartita	3	100	6
Linaria spartea	3	100	3
Linaria Prezii	3	600	1
211. Antirrhinum majus	3	900	475
Do.....do	8	....	nil.
Do.....do	9	....	nil.
Antirrhinum calycinum	3	25	9
212. Scrophularia vernalis	2	....	nil.
213. Collinsia heterophylla	3	900	578
Do	8	600	1
Do	9	....	nil.
214. Pentstemon, eight sp's	6	....	nil.
215. Mimulus moschatus	6	1,000	3
216. Digitalis lutea	3	300	46
Do	8	....	nil.
217. Veronica peregrina	3	....	nil.
Do	4	....	nil.
Campanulaceæ.			
218. Campanula medium	3	300	110

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
VALERIANACEÆ.			
219. Valeriana officinalis, valerian	3	300	17
220. Fedia dentata	5	50	3
DIPSACACEÆ.			
221. Dipsacus laciniatus	3	150	60
Do do	8		nil.
222. Knautia orientalis	3		nil.
COMPOSITÆ.			
223. Ageratum mexicanum	3	600	135
224. Aster tenella	3	600	120
225. Callistemma hortensis	3	600	161
226. Stenactis speciosa	3	300	18
Do do	8		nil.
227. Kaulfussia amelloides	3	300	114
228. Buphthalmum cordifolium	3	300	26
Do do	8		nil.
229. Zinnia elegans	2		nil.
Zinnia multiflora	3	450	37
Zinnia grandiflora	3	300	2
230. Rudbeckia amplexicaulis	3	450	55
Do do	8		nil.
231. Calliopsis tinctoria	6	150	3
232. Coreopsis atrosanguinea	3	300	138
Do do	8		nil.
Coreopsis Drummondii	2		nil.
233. Helianthus indicus, dwarf annual sunflower	3	75	68
Do do do do	8		nil.
234. Bidens diversifolia	3	450	124
235. Tagetes patula	3	200	20
Do do	4		nil.
Tagetes lucida	3	450	5
236. Gaillardia aristata	3		nil.
237. Helenium Douglasii	3	600	186
238. Callichroa platyglossa	3	300	92
Do do	8		nil.
239. Galinsogea trilobata	3	300	100
Do do	8		nil.
240. Sphenogyne speciosa	3	300	75
Do do	8		nil.
241. Oxyura chrysanthemoides	3	300	67
Do do	8		nil.
Do do	5		nil.
Do do	10	225	1
242. Madia splendens	3		nil.
243. Cladanthus arabicus	3	600	175
244. Lasthenia glabrata	3	600	363
Do do	3	100	58
Do do	3	*600	270
Lasthenia californica	8	400	4
Do do	9		nil.
245. Chrysanthemum coronarium	3	450	122

* In open jar.

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
246. Athanasia, sp	4	25	16
247. Ammobium alatum	3	600	1
248. Senecio doronicum	5	....	nil.
249. Xeranthemum annuum	3	600	64
Do.........do	3	....	nil.
250. Calendula maritima	2	100	26
Calendula officinalis, marigold	2	200	53
Calendula pulvialis	3	600	401
Do......do	8	....	nil.
Do......do	9	....	nil.
251. Arctotis, sp	4	100	48
252. Centaurea depressa	3	300	49
253. Kentrophyllum tauricum	3	25	11
254. Carthamus tinctorius	3	300	44
255. Onopordum tauricum	3	150	22
Onopordum acanthium	3	100	40
256. Arctium lappa, burdock	3	300	64
257. Rhagadiolus stellatus	3	100	34
Do.........do	4	50	31
258. Catananche cœrulea	3	600	94
259. Cichorium endivia, endive	3	450	260
Do......do......do	8	450	139
260. Tragopogon porrifolius, salsify	3	100	32
Do.........do......do	3	600	138
261. Arnopogon Dalechampii	2	30	10
Do..........do	3	100	10
Do..........do	4	....	nil.
262. Scorzonera hispanica, scorzonera	3	600	32
263. Picris echioides	2	100	73
264. Lactuca sativa, lettuce	3	150	1
Do....do....do	8	....	nil.
Do....do....do	9	....	nil.
265. Borkhausia fœtida	3	100	35
Borkhausia rubra	3	300	196
Onagraceæ.			
266. Œnothera tenella	2	100	1
Œnothera tetraptera	5	....	nil.
Œnothera, sp	3	....	nil.
Do....do	5	....	nil.
Do....do	10	1,800	1
267. Godetia lindleyana	3	300	90
Do....do	8	....	nil.
Godetia lepida	5	250	15
Do....do	10	....	nil.
268. Clarkia elegans	5	500	1
Do....do	10	1,500	1
269. Eucharidium concinnum	2	....	nil.
Do..........do	3	600	256
270. Lopezia racemosa	3	450	268
Myrtaceæ.			
271. Eucalyptus, sp	21	207	1
Loasaceæ.			
272. Loasa lateritia	3	450	112

General summary of the experiments—Continued.

Names.	Years old.	No. of seeds sown.	No. of seeds germinated.
Loasa nitida	3	300	52
Do do	8		nil.
273. Bartonia aurea	3	600	160
UMBELLIFERÆ.			
274. Petroselinum sativum, parsley	3	150	42
Do do do	8	100	1
Do do do	9		nil.
275. Carum carui, caraway	3		nil.
Do do do	3	600	2
Do do do	8	400	2
Do do do	9		nil.
276. Sium sisarum, skirret	3		nil.
277. Bupleurum rotundifolium	3	300	67
Do do	8		nil.
278. Œnanthe crocata	3	300	65
279. Æthusa cynapiodes	3	300	3
Do do	8	200	1
Do do	9		nil.
280. Fœniculum dulce, sweet fennel	3	200	84
Do do do	4	100	4
281. Ligusticum levisticum	3	300	35
Do do	8	200	2
Do do	9		nil.
282. Angelica archangelica	3	300	47
283. Pastinaca sativa, parsnip	3	300	20
Do do do	8		nil.
Do do do	9		nil.
284. Heracleum elegans, cow parsnip	3	150	17
Do do do	8		nil.
285. Daucus carota, carrot	3	300	79
Do do	8	200	1
Do do	9		nil.
Do do	8	900	37
Do do	10		nil.
286. Scandix brachycarpa	3	180	95
287. Conium maculatum, poison hemlock	3	300	144
Do do do	8		nil.
Do do do	5	150	2
Do do do	10		nil.
288. Smyrnium olusatrum	3	300	66

From the preceding table it will be seen that the seeds of no less than two hundred and eighty-eight genera, which illustrate seventy-one natural families, including, too, nearly all the kinds cultivated for culinary and other domestic purposes, have been collected, and to a certain extent tested. Many of them show a considerable decrease in the comparative numbers which vegetate after their periodical sowings, and a few kinds have apparently already ceased to germinate; but some years must yet elapse before the subject can be sufficiently investigated to enable us to submit what we should consider a decided and satisfactory statement respecting the limits assigned to the vegetative powers of the seeds in different genera.

In the Report of the Committee, on the 27th of August, 1857, it is stated that, after planting year after year all the seeds they were able to collect, they had then left but four species of plants the seeds of which continued to grow. These belonged to the genera Ulex, Dolichos, Malva, and Ipomœa. The shortest period for which any of these seeds had retained their vitality was eight years, and the longest forty-three years. Grouping the species according to their natural orders, the following selected will give some idea of those which retain their vitality longest: Gramineæ, eight years; Liliaceæ, ten years; Coniferæ, twelve years; Tiliaceæ, twenty-seven years; Malvaceæ, twenty-seven years; Leguminosæ, forty-three years; Rhamnaceæ, twenty-one years; Boraginaceæ, eight years; Convolvulaceæ, fourteen years; Compositæ, eight years; Myrtaceæ, eighteen years; Umbelliferæ, eight years; Cruciferæ, eight years.

PACKING OF SEEDS FOR TRANSPORTATION.

The manner in which farinaceous seeds should be packed for conveyance to distant countries is a subject upon which much speculation and no inconsiderable amount of money have been expended. But the results of experience, although sufficiently satisfactory, are by no means generally known; so that we find the old bad plans of packing still adhered to with as much tenacity as if they were proved to be excellent. It is, therefore, of the first necessity that the public mind should be at length disabused on the subject.

It almost always happens, that if two methods of doing a thing are promulgated, the world will believe that which is most complicated, or most unlike a natural process, to be the best; although it is, in all probability, the worst in those cases where the functions of life are in question; for however mysterious the workings of Nature may appear, they are always found to be less complicated, in proportion as we become acquainted with their real action. It is only in this way that we can account for the directions formerly given, and still observed in packing seeds—to bury them in charcoal, sugar, or in syrup; to swathe them in bandages, like a mummy, and then to smear the packages with melted wax; or, finally, to inclose them in vessels of glass or metal hermetically sealed; of all which modes of packing it is difficult to determine which is the worst. It is not worth the space it would occupy to discuss the separate reasons which led to

these various methods of embalming this class of seeds, because they have all been proved, experimentally, to be bad; we may, however, advert to one point connected with this process: The great object which everybody seems to have aimed at has been the exclusion of air, guided, no doubt, by the process which seems to be employed naturally when seeds are buried at great depths under ground. In such instances, the access of atmospheric air is cut off; therefore, it has been supposed that this is the only condition which it is necessary to secure, in order to suspend the vital energies of a seed. What has, perhaps, tended to confirm this erroneous opinion have been the stories current about seeds inclosed in mummy-cases for thousands of years having germinated. The newspapers abound in these tales, which appear to have produced a great sensation among their readers, as well they might, considering that the grain deposited with the mummies was usually roasted. We have ourselves seen several such instances; and the crafty Arabs, who impose upon travellers, deserve some credit for their ingenuity in purveying something different from the common wheat, when they sell visitors these antiques. No doubt can exist that the wheat thus capable of germinating, if taken from mummy-cases at all, was put there first by the venders themselves. It is, however, to these instances that we may ascribe the origin of wrapping seeds in wax-cloths, like the cerements of the dead, or soldering them up in metal boxes, or hermetically sealing them in glass.

That seeds buried at great depths under ground will grow after hundreds of years is beyond all controversy; and that seems to be the only real evidence we possess about excessive seminal longevity.

Other well-attested instances are derived from seeds picked from collections of dried plants; no case among which, however, carries the suspended vitality of seeds beyond a hundred years. In the first case, air was excluded; in the other it had free access. We therefore cannot suppose that the exclusion of air explains the power which some seeds possess of living for many ages.

It is obvious that any contrivance which keeps out of a packet of seeds the air of *our* atmosphere, will keep in the air of *theirs*. Now, the air of our atmosphere is dry, or, if occasionally damp, soon becomes dried, if seeds are exposed to it in a room in which we live. On the other hand, many seeds are necessarily damp, and they communicate their moisture to the air that surrounds them; the papers, too, in which they are packed are damp, as may be seen by holding such papers before a fire, when the damp will dry off in the form of vapor; and if this air, which surrounds the seeds, is enclosed in an air-tight vessel of any kind, it must always remain damp, because it cannot be changed by ventilation. We may therefore assume that such seeds in air-tight vessels are damp, but in situations freely communicating with the atmosphere are comparatively dry.

So long as seed-packages are kept at a low temperature, this difference is of no moment; because seeds cannot germinate, or, in other words, cannot revive from their torpor, in a low temperature; but let the temperature rise, and the case is altered. What seeds require,

in order to grow, are exclusion from light, moisture, and warmth; they cannot grow in damp without heat, nor in warmth without moisture. It is the combination of these two conditions that is absolutely requisite. When they arrive in warm latitudes, or are placed in warm situations, such as the hold of a ship, the seeds in air-tight cases, being surrounded with moisture, attempt to grow; those, on the contrary, which are in ventilated packages, not being surrounded with moisture, remain unchanged.

The commencement of growth made by the seeds in air-tight cases is presently arrested, in consequence of the unfavorable circumstances under which it takes place, and the seeds, not being able to return to the state in which they were before they began to germinate, immediately perish; but the seeds in ventilated packages, not having begun to grow, still remain unaltered.

The irresistible conclusion from this is, that the true mode of packing farinaceous seeds for long voyages is, to put them in well-ventilated packages, and not in closed-up cases. Such dryness as seeds can acquire from exposure to the air cannot hurt them, but will, on the contrary, tend to preserve their germinating powers.

To emigrants, then; to seedsmen sending consignments to distant countries; to the lovers of flowers, whose friends in distant parts of the world remit them parcels, we recommend the strict observance of the following rules:

1. Let the seeds be *thoroughly dried* by exposure to the sun, (not fire,) or in a dry chamber or loft; this is of the first importance.
2. Let the papers, also, or canvas bags in which they are packed, be equally dried.
3. Let the smaller packages be tied up separately, and then placed *loosely* in canvas bags or coarse sacking, so that they can be readily disturbed by shaking up during a voyage.
4. Let arrangements be made for these bags being kept in a dry cabin, or some well-ventilated part of the ship. To the latter, we know that captains make objections; but these are merely on the score of expense. The payment of additional freight for such accommodation will always secure the situation that is desired.

These statements, it is to be observed, are not made rashly, nor from mere theoretical views of a very interesting question, but from the experience of many years; and we strongly urge our readers to follow the directions we have thus given them. We must, however, add, that there are a few sorts of seeds, such as coffee berries, acorns, chestnuts, mangoes, magnolias, araucarias, &c., which require to be packed in earth or sand, excluded from the air, or hermetically sealed, and sown *immediately* after being opened.

D. J. B.

CULTIVATION OF ASPARAGUS IN THE NORTH OF SPAIN.

[Condensed from a paper from Captain Churchill, of the Royal Marines, to the London Horticultural Society.]

Asparagus is probably the vegetable most generally admired and most seldom well cultivated; it is only here and there that it is large, tender, and delicate. In country gardens, it is small, green, and strong; in the London market it is long, white, hard, and tough—to the eye attractive enough, but to the taste more like bleached timber than an esculent. For this reason, when really fine asparagus is met with, people think it must be some peculiar sort—obtain the roots from Vienna, Berlin, Hamburg, Battersea, or Deptford, and then, when they find them producing heads identical with what they had before, lay the blame on the seedsman, the soil, the climate, or anything rather than their own want of skill. There is but one asparagus, be its name what it may; all the differences consist in its cultivation.

Captain Churchill says the Guipuscoan asparagus measures from 3 to 6 and more inches in circumference. How this is obtained, his excellent account leaves no room to doubt.

This plant is found naturally on the beach of various parts of the coast of Europe, where it is covered by the drifting sand, and watered by salt-water at high tides. Sand and salt-water occasionally may, therefore, be regarded as indispensable conditions for maintaining it in health. It, however, explains, in part, the excellence of St. Sebastian asparagus.

It seems that at the mouth of the Urumea is a narrow slip of land, about 3 feet above high-water mark, consisting of alluvial soil and the wearing away of sandstone hills, at the foot of which it is placed. This is the asparagus ground of St. Sebastian. Beds are formed 5 feet wide, without any previous preparation, except digging and raking. In March, the seed is sown in two drills, about 2 inches deep and 18 inches from the alleys, thus leaving a space of 2 feet between the drills. The rows run invariably east and west, doubtless in order that the plants may shade the ground during the heats of summer. When the seedlings are about 6 inches high, they are thinned to something more than a foot apart. Water is conducted once a day among the alleys and over the beds, so as to give these seedlings an abundant and constant supply of fluid during the season of their growth. This is the cultivation during the first year.

The second year, in the month of March, the beds are covered with 3 or 4 inches of fresh night-soil from the reservoirs of the town. It remains on them during the summer, and is lightly dug in during the succeeding autumn, the operation of irrigation being continued as during the first season. This excessive stimulus, and the abundant room the plants have to grow in, must necessarily make them extremely vigorous, and prepare them for the production of gigantic sprouts.

In the third spring, the asparagus is fit to cut. Doubtless all its

energies are developed by the digging in of the manure in the autumn of the second year, and when it does begin to sprout, it finds its roots in contact with a soil of unsurpassable fertility. Previously, however, to the cutting, each bed is covered in the course of March very lightly with dead leaves, to the depth of about 8 inches; and the cutting does not commence till the plants peep through this covering, when it is carefully removed from the stems, in order that the finest only may be cut, which are rendered white by their leafy covering, and succulent by the excessive richness of the soil.

In the autumn of the third year, after the first cutting, the leaves are removed, and the beds are again dressed with fresh night-soil, as before, and these operations are repeated year after year. In addition to this, the beds are half under salt-water annually at spring-tides.

Let any one compare this mode of culture with ours, and there will be no room for wondering at the difference in the result. The Spaniards use a light, sandy soil; we are content with anything short of clay. They irrigate; we trust to our rainy climate. They know the value of salt-water to a sea-coast plant; we take no means to imitate Nature in this respect. They dress their beds with the most powerful of all manures; we are content with the black residuum of a cucumber frame, which is comparatively a *caput mortuum.* Finally, they throw leaves lightly over their beds, by which means they expose the young sprouts to the least amount of resistance, and force them onward by the warmth collected from the sun by such beds of leaves; we, on the other hand, compel the asparagus to struggle through solid earth, capable in the smallest possible degree of absorbing warmth during the day—but ready to part with its heat again at night to the greatest possible amount.

D. J. B.

HOP-CULTURE.

CULTIVATION OF THE HOP IN ENGLAND.

[Condensed from authentic sources.]

The hop, as is well known, is cultivated to a considerable extent in Belgium, Bavaria, and in the Middle and Northern States of our Union; but it is produced in the greatest abundance in the counties of Kent, Sussex, Surry, Hampshire, Worcestershire and Herefordshire, in England, and to a more limited extent in Essex, Suffolk, Nottinghamshire, and the British antipodean colonies.

Among the varieties of the hop at present under cultivation in England, which have not yet been introduced into the United States, may be mentioned the following:

1. The first in rank are the Farnham and Canterbury "White-

bines." These are so much alike that they seem to be the same variety.

2. The "Goldings," which are little, if at all, inferior to the preceding, are stronger, but not quite so finely flavored; and when growing, they may be distinguished from the other two by the bine being somewhat larger and the hops hanging more singly on the branches. The bines of all the above varieties are specked with reddish-brown. They require the longest poles in use, varying, according to the soil, from 14 to 30 feet. The main roots run deeper into the soil than any other variety, and their plants are the most enduring upon the same land.

3. The "Grapes," of which there are several subdivisions, grow in clusters; whence they derive the name. They differ much in quality, the smaller sorts being superior, some of which, when grown on good land, nearly approach to the Goldings in value, while the larger descriptions, such as are usually cultivated in Sussex and the Weald of Kent, are coarse and of inferior quality. The bines of the Grapes are small, of a light-green color, and require poles of from 10 to 14 feet in length.

4. "Jones' hop," the bine of which is red, grows on lighter and inferior land, merely requiring refuse poles of from 8 to 10 feet in length. The crop of this variety could be much increased, if the top bines and branches were trained and interlaced from pole to pole.

5. The "Colegates," which are a very hardy variety, grow best upon stiff soils. Although late in ripening, they run up a long pole. The hop is small, and hangs from the branches in thick masses; but it is a sort not much esteemed by the brewer, as it is liable to be injured by mould. The color of the bine is a pale green, like that of the Grape, but larger.

6. The Flemish "Redbines," which will grow on light silicious soils, generally escape the aphis, or black blight; hence they are commonly known by the name of "Never-blacks." They produce a poor, thin hop, and, except from their favorable tendency to escape the aphis blight, they can in nowise be recommended.

Agricultural chemistry has only very recently been employed in the service of the hop-grower. A few analyses will manifest the important agency which this science exercises over the process of this field of industry, and should indicate to the planter the expediency of availing himself of the knowledge of its benefits. The following are analyses of the mineral ingredients of the hop, as determined under the direction of the Royal Agricultural Society of England:

No. 1 is the analysis of the produce of four hills of hops, grown in Farnham. They were of the Whitebine variety. The sub-soil upon which they were cultivated was the soft marl rock, resting immediately upon the phosphoric band of the upper green-sand of the chalk formation.

No. 2 was from three hills grown at Hadlow, in Kent. They were of the "Yellow-grape" variety, and were produced upon the Wealden clay. Both samples were examined in their manufactured state, in the ordinary condition in which they were prepared for sale.

No. 3 was grown at Bentley, in Hampshire, upon the out-cropping of a phosphoric stratum of the chalk formation. The specimen was taken from two hills of the Farnham Whitebine variety, consisting of all the hops, leaves, and bines, which were carefully preserved, and dried artificially for the experiment.

Analyses.

	No. 1. FARNHAM WHITEBINE.			No. 2. KENT YELLOW-GRAPE.		
	Hops.	Leaves.	Bine.	Hops.	Leaves.	Bine.
Per-centage of ash on dry matter	9.90	16.33	5.00	15.80	25.11	5.10
Analysis of the ashes.						
Silica	20.95	10.14	4.64	24.96	20.38	5.66
Chloride of sodium	7.05	7.92	4.95	3.18	4.58	9.98
Chloride of potassium	1.63	....	7.38	2.21	....	....
Soda	....	0.32	....	....	2.29	2.32
Potash	24.50	12.48	18.62	18.61	5.13	12.97
Lime	15.56	41.46	29.59	23.75	32.28	17.39
Magnesia	5.63	1.99	3.15	6.13	6.24	12.61
Sulphuric acid	5.27	4.20	2.63	4.16	3.63	3.14
Phosphoric acid	9.54	2.02	5.22	5.26	3.68	8.14
Phosphate of iron	7.26	2.93	0.31	6.79	0.54	2.06
Phosphate of alumina	....	....	....	....	....	1.55
Carbonic acid	2.61	16.54	23.51	3.36	21.25	24.18
Manganese	....	....	....	1.59	....	trace.
	100.00	100.00	100.00	100.00	100.00	100.00

No. 3.	Hops.	Leaves.	Bine.
Per-centage of ash on dry substance	9.00	21.94	7.28
Composition of the ashes.			
Silica	19.16	22.35	9.99
Chloride of sodium	0.74	3.12	2.63
Chloride of potassium	8.96	2.29	15.35
Soda	....	....	....
Potash	31.70	13.13	17.60
Lime	9.59	30.78	23.91
Magnesia	4.80	4.84	3.77
Peroxyde of iron	0.68	0.19	0.80
Sulphuric acid	5.10	1.89	2.33
Phosphoric acid	17.33	9.33	11.69
Carbonic acid	1.92	12.04	11.92
	99.98	99.96	99.99

As the crop from the latter (No. 3) was a full one, and of a healthy character, a statement is subjoined showing the amount of inorganic matter removed from the soil by a large crop. The actual amount grown was about a ton, or 2,240 pounds of hops per acre, which nearly coincides with the quantity found by calculation from the two experimental hills, after making allowance for the water still retained in the manufactured crop. There were twelve hundred hills to the acre.

	Produce of two hills.	Per acre dry matter.	Ash per acre.
	Pounds.	*Pounds.*	*Pounds.*
Hop flowers	3.50	1,894	170.43
Leaves	3.75	1,984	435.06
Bine	3.25	1,781	129.54

Composition of the ashes in pounds, removed by an acre of hops, with leaves and bine—

	Hops.	Leaves.	Bine.
Silica	32.65	97.28	12.95
Chloride of sodium	1.26	13.58	3.40
Chloride of potassium	15.26	9.96	19.90
Soda	....	....	....
Potash	54.01	57.15	22.81
Lime	16.33	133.98	30.99
Magnesia	8.17	21.06	4.88
Peroxyde of iron	1.14	0.82	1.03
Sulphuric acid	8.69	8.22	3.02
Phosphoric acid	29.53	40.61	15.15
Carbonic acid	3.39	52.40	15.41
	170.43	435.06	129.54

The following is the amount of nitrogen required for the above crop:

	Hops.	Leaves.	Bine.
First experiment gave a per-centage of	2.96	2 51	1.33
Second....do.............do	3.00	2.43	1.35
Mean	2.98	2.47	1.34

Thus, the above crop removed 56.44 pounds of nitrogen per acre in the hops; 49 pounds in the leaves, and 23.86 pounds in the bine—the total amount removed being 129.3 pounds per acre, or nearly equal to that which is supplied by 1,000 pounds of good Peruvian guano.

The foregoing analyses should convince the hop-grower of the economical expediency of preserving all his refuse bines and leaves, in order that they may be returned to his land; for the nitrogen alone could not be obtained in other manures for less than $20 per acre, not to mention the value of the phosphoric acid and potash amongst the mineral ingredients.

An inspection of the tables will also demonstrate that the hop is one of the most exhausting among cultivated plants, both in respect to the organic and mineral constituents which it extracts from the soil. It would be so, if it merely occupied a place in a rotation series of crops; but, as a perennial growth, we should expect to find it as exhausting a crop as in practice it is proved to be. It follows, therefore, that the naturally most fertile soils should be chosen for its cultivation, such as are usually found already formed in valleys from the débris of the surrounding country, the valleys of the present era, or in the more lately-formed alluvial deposits near existing rivers. Those soils are commonly recognized as rich, friable loams, possessing a natural drainage, and yet retaining a high degree of tenacity for water. There are also certain classes of soil very dissimilar from these loams, in respect to situation and appearance, which are most genial to the growth of hops; these are outcrops of certain geological strata, the rock of which was once the detritus of a remote era in the history of our globe; they are generally rich in organic remains, and these remains, in their analytical constituents, closely resemble the hop itself; and there is a third class of soils most unfitting for the growth of hops in its natural condition, but which, by skillful draining, deep cultivation, and consequent aeration, may be made equal to the most naturally fertile soils.

The peculiarities of the soil of each hop district in England, it will be understood, are chiefly dependent upon its geological characteristics; and this circumstance also gives rise to the difference in the estimation in which the hops are held by dealers and brewers, partly from the soil communicating certain valuable properties to the hops grown upon it, and partly on account of the more valuable varieties being able to be grown on the one and not on the other. Thus, those in the Farnham district are chiefly produced upon the outcrop of the upper green-sand, and on a deep diluvial loam lying in the valleys beneath; in East Kent, upon a rich, deep loam, resting upon the upper chalk and plastic clay; in Mid Kent, upon the ragstone rock of the lower green-sand; in West Kent, chiefly upon an out crop of the upper green-sand and gault, and in the Hill Grounds, upon the upper chalk; in the Weald of Kent and Sussex, upon Hastings sand of the Wealden formation; and in the Worcester district, upon the marls of the new red sandstone. These, of course, are merely the leading and more prominently distinctive peculiarities of each district, which are not unfrequently modified, and sometimes wholly changed, by abrupt geological disturbances.

The following analyses will best indicate the nature of the soils of the phosphoric strata of the chalk formation. No. 1 is the grey marl, which lies directly upon the green stratum, and which is also

famous for growing large crops of wheat and beans, alternately, with little or no manure.

No. 2 is the green soil, with which are intermixed many fossils, that are separated prior to analysis:

No. 1.

	Per cent.
Insoluble silicious matter	19.64
Soluble silica	6.45
Soda and potash (not estimated)	....
Lime	37.71
Magnesia	0.68
Oxyde of iron and alumina	3.04
Phosphoric acid	1.82
Carbonic acid	28.98
	98.32

No. 2.

Insoluble silicious matter	32.81
Soluble silica	29.14
Organic matter	3.02
Potash	3.10
Lime	9.53
Magnesia	1.97
Oxyde of fron and alumina	11.46
Phosphoric acid	6.61
Carbonic acid	2.30
	99.94

The fossils, themselves, which are thickly interspersed in this soil, usually contain about 30 per cent. of phosphoric acid, and from 2 to 3 per cent. of potash. It may here be remarked, that to the extraordinary richness of these soils in lime, potash, and phosphoric acid, may be attributed their adaptation for the growth of the hop, as, indeed, the analyses of this plant would indicate.

The gault soil, which is still richer in potash than the above, has also an abundance of phosphoric nodules and organic remains.

The characteristic geological feature of the Mid Kent district is the abundance of the well-known ragstone rock, which is frequently dispersed with green grains. The following is an analysis of the latter by Professor Way:

	Per cent.
Soluble and insoluble silicious matter	18.53
Water	2.28
Potash	1.79
Soda	1.87
Lime	34.61
Oxyde of iron	7.24
Alumina	.98
Sulphuric acid	5.13
Phosphoric acid	20.65
Carbonic acid	4.01
	97.09

A mass of the rock, broken up, gave:

Insoluble silicious matter	30.60
Phosphoric acid	7.23
Potash	3.31
Soda	1.02

In some cases, chemists have found as much as 10 or 12 per cent. of potash in these green grains. These analyses also show that this particular soil, like that of the Farnham district, has been appropriately chosen for the cultivation of hops.

CULTIVATION.

The preceding observations, relative to the geology of existing plantations of hops in England, will indicate, in a general way, the description of soil to be selected for new ones. The variety of hop, too, is by no means a matter of indifference, inasmuch as some of the coarser kinds will flourish on soils where the more delicate will not grow at all. The Goldings, and the Farnham and Canterbury White-bines, are the deepest rooted, and prefer either the sub-soil rocks of the upper and lower green-sands, or a deep friable loam. They also do well on the gault clay, provided great care be taken to secure deep drainage. The roots of these sorts have been traced 20 to 30 feet deep in the crevices of a stone quarry. The other varieties are more shallow-rooted, and will grow on inferior land, and with less careful drainage.

Having chosen the site for a new plantation, the ground is trenched, or subsoil-ploughed, or deep holes dug, early in October. The plants are raised by cutting off the layers, or shoots, of the preceding year. These are bedded out, in March or April, in ground previously trenched and well manured, which, by the succeeding October, become what are termed "nursery plants," or bedded sets; or the cuttings themselves are planted out the same year; but this plant is not recommended, although less expensive, since, in a dry spring, there is great risk of their dying. Plants, too, are obtained from the seeds of ripe flowers, which cannot be set out, however, until they have been *proved;* for, like apples and many other fruits, the plants seldom

partake of the character of the parent, and at least one-half will be males, while, of the female plants, probably not one in fifty is worth saving. Nevertheless, a good variety is occasionally procured by this means, and, when thus obtained, it must afterwards be propagated, as in the old sorts, by layers. If the nursery plants be used, it is desirable to set them as early as November, and, at any rate, if the weather be open, the earlier they are planted in the course of the winter the better. When cuttings are used, they are planted without loss of time, in March. They are set in squares, or triangles, at equal distances, generally from 6 to 7 feet apart. The triangular planting possesses an advantage over the square, as, when three poles to a hill are employed, it allows the hop "nidget," or scarifier, more completely to move all the ground on the outside of the poles, which is a matter of some importance. With regard to distances, as a general rule, 6 feet is preferred for square planting, and 6½ feet for triangular; but when it is intended to plant either the Farnham, or Golding, or Canterbury variety, and to place three poles to a hill, 6½ feet for squares, and 7 feet for triangles are considered preferable, especially if the land be good. For very fertile grounds, the distances are further increased, sometimes to 9 feet in square planting, having poles from 20 to 30 feet in length. In all these matters, however, the exercise of judgment is required.

The best method of setting out the young plantation is by means of the common land-surveyor's chain, having the distance indicated by the feathers or quills of fowls. Sticks are then inserted at each mark, where holes are dug, and the hops planted.

Trenching is considered to be, in the first instance, the preferable mode of preparing the ground, especially when meadow or pasture land is to be broken up, where, indeed, it is almost indispensable. In this, as in every other case where trenching is adopted, care is taken not to bury the surface-soil too deeply, but leaving it within reach of the spade, when the ground is dug over the following year. Very deep trenching for hops, even when the top-soil is not buried deeply, is by no means advisable, provided there be no pan-table, or incrustation, below. Eighteen inches is usually a sufficient depth. It may be stated, as a reason for not burying the surface mould very deeply, that, although the main roots of the hop penetrate to a great depth, yet that the smaller rootlets, with their spongioles, run only just below the surface, and the manuring ingredients are continually washing downwards. We have also pretty good grounds for believing that rich soil buried deeply becomes inert. Deep digging answers very well, if the land be taken from arable cultivation, provided it be in a clean condition. In those districts in which manual labor is scarce, there is no reason why it should not be resorted to. If holes are dug, they should be about 20 inches square, and 2 feet deep. In this case, after the hops are planted, the residue of the ground must be dug up deeply. There is, however, very little, if any, saving of expense by this method, when the after-cultivation is taken into account.

After either of the above processes has been determined upon, the

next consideration is the application of appropriate manures. When the ground has been trenched or sub-soiled, if it be in "good heart," no manure is required at the time of planting; but if the ground be poor, it is desirable to dig small holes, about a foot square and 15 inches deep, and put into the bottom of each hole a spit of good dung compost, or a few rags, hair, or any kind of animal refuse, but on no account to use guano or the salts of ammonia at this period. When large holes are dug as a substitute for trenching, it is almost always advisable to put in some manure, which should be mixed up with the soil, instead of being placed at the bottom of the holes.

If nursery or bedded sets be employed, one, two, or three plants may be used to form a hill, according to the strength of the plants. One is sufficient, if it be a large, strong, healthy plant, and if great pains and attention be bestowed upon the subsequent management. When cuttings are used, it is safest to plant five to each hill, which should be dibbled in round one as a centre. Each cutting should have an inch of earth between it and its fellow. In the planting of new grounds, attention should be paid to the introduction of a sufficient number of the *male plants.* One hill in two hundred, or about six on an acre, are considered ample. They ought to be planted at regular and known intervals, in order that, in subsequent years, the cuttings saved from these grounds may not become indiscriminately mixed. The introduction of these male plants is a matter of extreme importance, and ought on no account to be neglected; for it is an established and indisputable fact, that the grounds which possess them are more prolific, and bring the hops to maturity earlier than those plantations which are deficient in them, and, in addition to these advantages, the hops are of a better quality.

The subsequent cultivation of a new plantation requires constant attention. The ground must always be kept quite clear of weeds, and should have a good depth of pulverized soil. In the latter part of the spring, a stick, about 6 or 7 feet high above ground, should be placed to each hill, if planted with "nurseries," and about 4 feet high if planted with cuttings; to these sticks *all* the young bines, as they shoot out during the summer, must be tied up. At the end of May, or the beginning of June, a dressing of guano and superphosphate of lime should be applied, at the rate of 300 pounds of the former and 100 pounds of the latter per acre. This should be placed in equal quantities around each hill and hoed in, taking care not to allow any of the mixture to come in contact with the plant. Another and similar manuring should be applied in July, and after this, the hills should be earthed about 6 inches. The above quantities of guano, &c., may appear extravagant, but it must ever be borne in mind that young hops cannot be two strong; for, unless they be very strong, they will not come into full bearing the next year. This recommendation is the result of a long and extensive experience. The cost, too, is often repaid in the same year, by the growth of 200 or 300 pounds of hops per acre. When the hops from these nursery grounds are picked, the bines must not be cut, but the hops must be gathered from the sticks, as they stand, into small baskets. The bines

and sticks should not be taken up till November ; for the young plants would be most seriously injured by the escape of sap if the bines were cut while in a growing, succulent state. It is customary to intercrop a newly-planted field with mangold-wurzel, cabbages, turnips, potatoes, carrots, &c., and this is not objectionable, if the land be clean, and the requisite manures for these crops be not stinted.

In all meadow, pasture, or grubbed coppice land, and wherever a deficiency of lime in the soil is suspected, a dressing of quicklime, at the rate of 200 bushels per acre, applied in the spring of the second year will be found beneficial. This should be dug into the ground as soon as it is spread, and, of course, no ammoniacal manures must be put on at the same time.

In the management of established hop-grounds, it may be laid down, in the first place, as a positive rule, that no work should be done either by horses or men in wet weather, or whenever the land poaches, or kneads, and that all weeds should be extirpated as they spring up. The general system of cultivation will probably be best understood in its chronological order.

Commencing, then, in the month of October, as soon as the preceding growth has been gathered in, the haulm, or bines, are stripped off the poles as early as practicable, unless this process has previously been done by spare hands before the hop-picking of the farm has been completed. The haulm are carefully preserved and taken to the homestead, where they are used as a substitute for straw. They are stacked in ricks, and cut out like hay when required for bedding in the cattle-yards. The chemical analyses, which have been inserted, show that a large amount of valuable mineral and organic manure is thus preserved for the replenishment of the land. When taken direct from the hop-ground, and spread evenly over arable land, the haulm, too, are regarded as one of the best manures for potatoes; they are suffered to lie upon the surface throughout the winter, during which time, the leaves are detached, and are subsequently dug or trenched in for the potato crop, the remaining stalks being used for other purposes. They are, also, an excellent manure for oats similarly applied. That portion of the stalk which grows near the ground is useful, if stored away when dry, for making bandages or withes. The poles, when stripped, are stacked or hiled in straight lines through the plantation; each stack or hile usually containing four or five hundred poles. By "stacking," is meant the horizontal process in which the tops of the poles are brought together into the middle of each stack, thus leaving only the butt-ends exposed. The stack is supported about 18 inches above the level of the ground by three narrow mounds of earth, upon which are placed a few pieces of worn-out poles for the sound ones to rest upon, in order that they may not come in contact with the damp soil. In "hiling," the poles are set up on end, about one hundred being placed in each of four squares, the tops meeting so as to form the apex of a cone. When the poles are preserved during the winter in this manner, the hop plantations present the appearance of an extensive encampment. The latter

mode of preserving the poles is preferable, as it allows them to dry more speedily.

In November, and during the winter months, as opportunities permit, the poles are sorted, and repointed as required; afterwards, re-hiling those which are suitable for the ground in which the work is performing, and taking away the smaller ones for young plantations, or for those grounds and varieties of hops that require a shorter kind of poles. Experience alone teaches the hop-grower the length of poles best adapted to his several plantations; and as this is an element of considerable importance in securing a successful result, an attentive observation is bestowed upon this branch of his art. Drainage, which had been neglected when the ground was planted, is now commenced; the hops being planted in straight rows afford every facility for this undertaking. The drains are from 4 to 5 feet deep, having a two-inch pipe or tile at the bottom, with a covering a foot thick of broken stones or chalk, if obtainable, as this covering prevents the roots from entering the pipes. All stiff soils, such as the gault and Wealden clays, require drainage in order to insure successful results; and, in these soils, it is almost impossible to place the drains too deeply or too close together; and all those soils which only occasionally, in wet seasons, contain a redundancy of water, pay well for draining; but the drains in such classes of soil are put in at wider intervals. It may here be mentioned that much damage is often produced upon hop grounds by the overflow of surface water from roads and lanes in the spring of the year, when the hop plant is in its tender stage. This causes the root to rot, and the bines then canker off.

During the three winter months, every opportunity of frosty weather is seized upon to convey to the grounds new poles and manures. On the free working soils, digging is performed whenever the weather is open and dry. This operation is effected by a "spud," or three-spaned fork. The spanes, or tines, when new, are about 12 inches long, which enables the laborer to move the ground thoroughly 8 or 9 inches deep. Great care is observed that the digging is well done, as it is the foundation of all subsequent labor.

In March, no time is lost in completing the digging; for the dry weather which usually occurs in this month affords an opportunity of putting the stiff lands in good condition, so as to insure a proper tilth throughout the ensuing summer. It is regarded a wise economy, therefore, to employ as many hands as can be procured, in order to dig up the stiff ground quickly, in favorable seasons. The next process is that of cutting or pruning the hill, which, on no account, is delayed beyond this month, while the earlier it can be done the better; and if from any cause the ground has not been dug, rather than wait too long, the operation of cutting precedes the digging. When the ground has been dug, the cutting process is executed by means of a "beck," or pronged hoe, by which the earth around the hill is removed, so as to expose the bines of the preceding year down to the crown of the roots, as well as any suckers or offsets which may have sprung from it. The latter are cut off cleanly with a sharp knife, leaving

the crown in a convex shape, about 6 inches below the level surface of the ground. From half an inch to an inch of the last year's shoots are permitted to remain. The crowns are then left exposed for a day or two, after they have been trimmed, in order to dry, when they are covered with a thin coating of fine earth, care being observed at this time, by sticking up a cutting, to mark those hills which are weakly and will require smaller poles. When the ground has not been dug, the same process is followed, after having cleared away the earth around the crowns of the root. That portion of the bine of the preceding year, which had been earthed up the summer before, and which has consequently become much enlarged, is the part taken to plant new hop grounds, or to make bedded sets.

After the cutting or trimming is completed, and continuing the work through the month of April, the poles are set up, commencing with those grounds that have not been dug, the digging being finished immediately after the poling. It will here be necessary to revert to the lengths and number of poles which the various soils and different varieties of hop require: In large plantations, and frequently in the same field, a very different kind of poling is requisite, which demands the attentive study of the hop-grower; for a correct knowledge of the capabilities of the soil can only be obtained by experience, which, however, will be greatly aided by a little geological information, as the out-cropping of some of the peculiar strata of the hop districts. Under and over-poling are extremes equally to be avoided. As a general rule, the longer the poles the less number is required. The Farnhams, Canterburys, Goldings, and Colegates demand longer and fewer poles than the Jones and the several sorts of Grapes; the refuse poles of the former being well suited for the latter. The poles vary from about 10 to 20 feet in length. The first four varieties of hops generally require them from 14 to 20 feet long, the Grapes from 10 to 14 feet, and for the Jones even shorter poles suffice. When there are about twelve hundred hills on an acre, and the poles 18 feet long, and upwards, two are used to each hill; with sixteen-foot poles, every third hill has three; with fourteen-foot poles, two and three alternately; with twelve-foot poles, three; and with ten-foot poles, three and four alternately, or, perhaps all fours for the Jones and Grape varieties. Here, again, the sort of hops is taken into account; for, if they be Grapes, grown on rich land, then three fourteen-foot poles are not considered too many. With the increased distances between the hills, a proportionately increased number of poles are supplied. It is conceded, however, as a useful maxim, that it is not wise to overcrowd a field with poles, as the fruit would be rendered imperfect, and in a wet season, with a biney growth, it frequently happens that the crop is much diminished by having too many. It is thought to be a better plan to pole rather sparingly at first in long-poled grounds, and about the beginning of June to set up some extra poles at the strongest hills, taking off a bine from each of the other poles to furnish them with. The poles are set up by means of an implement called a "hop bar," or "hop pitcher," similar, but larger than the common iron bar used for making holes for fence stakes. Each pole is punched

into the hole made for it, by the full force of a man's strength, in order that it may resist the wind when it is loaded with bines and hops. The poles are put up symmetrically, equidistant from each other, around the centre of the hill, from which each is about 10 or 12 inches; and they are so spread out at the tops as equally to intersperse the area formed by the tops of all the poles, by which means each pole will receive its due share of sunshine and air. The stiffest poles, and those somewhat shorter than the average, are selected for the outside rows. In exposed situations, and with short poles, it is also regarded as a good plan to tie up horizontal ones to the two outside rows, as they form a protection against wind, while the increased crop of hops more than defrays the extra expense. After the poling, the ground is immediately pared over with the hoe, in dry weather, if there be any spring weeds, which is generally the case after a mild winter, and especially if the ground has been dug early. This hoeing is followed by a second digging, or the ground is broken up by a horse scarifier. If the ground be dug, it is not broken so deeply as in the winter, nor is the surface left rough. If the scarifier be used, two horses are required to work it. This scarifier, or nidget, is a kind of cultivator, having handles like a plough, and is specially designed to work between the rows of hops. It is held by a man, and the horses led by a boy. Some persons also use the beck to move the ground at this period.

Early in May, the bines or young shoots from the plants, are usually long enough to tie to the poles, which is done as soon as they will reach them, as they become much injured by lying upon the ground and twisting together. Three of the most even bines are selected for each pole; the strong, rank ones being rejected, if there be a probability of enough coming out to supply the poles. They are tied with rushes, or old Russian matting. After this, and until the bines are grown to the tops of the poles, they occasionally require ladder-tying; which is usually done by boys, by means of a double or step-ladder, made in the form of a letter A.

The earthing up, as above alluded to, is done within the first fortnight, or three weeks in June. The hills are earthed up about 18 inches high, which is done for the sake of preserving the crowns of the roots in a growing state, as well as for keeping back the young shoots that would otherwise sprout out from the hill. As soon as the hops are earthed up, or "hilled," as it is provincially termed, all the weak plants receive an extra manuring. This is most cheaply and efficaciously accomplished by portable artificial manures, such as ground rape-cake, muriate or sulphate of ammonia, or nitrate of potash, mixed with equal quanties of Peruvian guano, or superphosphate of lime. After the hilling is completed, the nidget, now drawn by one horse, is introduced, if it has not been used before, and is continued to be employed until about the middle of August; but in that month, the teeth or hoes are set more shallow. In small plantations, and where manual labor is abundant, the beck is advantageously substituted for the nidget. During this period of about six weeks, the hills and those parts of the ground which the nidget does not touch,

are cleared of weeds by the hoe or beck; and the suckers from the hills are pulled off, for if they be suffered to remain, they invariably have a tendency to mould. If the weather be wet, so as to prevent the horses working on the land, the hoe is unsparingly used between the rains, to keep down the weeds.

From the beginning to the middle of July, the Goldings, the Farnhams, and the Canterburys often require the lower branches to be cut off, from 3 to 4 feet from the ground, and when the poles are extremely long, a foot higher. This is done to insure a more perfect circulation of air and light, as these sorts, on good land, are apt to grow bushy at the bottom of the poles, and cutting them off is a precautionary prevention of mould. After the nidget or beck has been discontinued—that is to say, from the middle of August to the time of picking—the ground is passed over once or twice with the hoe, to destroy the seedling weeds and preserve the land in a clean condition for the following year.

The commencement of the hop-picking varies with the state of the season. It usually falls between the beginning and middle of September, though in rare instances, the hops may be ready before, or retarded beyond these periods. It is highly important that they are not picked until they are fully ripe, and then they are gathered with all possible expedition. A hop is considered ripe when it becomes hard and crisp to the touch; when the extreme petal projects in a prominent manner at the tip of the strobile, the color is changed from a light silvery-green to a deep primrose-yellow; and when, on opening it, the envelope of the seeds is of a purple color, and the kernel, or seed itself, hard like a nut. Even after the hop has attained a lightish brown, no real injury to its quality will have accrued, and, for many purposes, such hops are most esteemed; but after the hops generally attain a dark-brown hue, a great loss, both in quality and weight, is sustained. It is almost impossible to pick all the hops on large plantations at the critically proper time; yet, as some grounds ripen earlier than others, it is of interest to the hop-grower to watch them attentively at this juncture, lest a mistake be made in their comparative maturity, and even in different parts of the same field.

From the cool, moist climate of England, it is necessary to resort to kilns for drying the hops; but in this country, where the climate is usually dry, "oast-houses," or kilns, are not much employed. As the great object, in England, is to get rid of the "reek," or condensed vapor from the green hops, as quickly as possible, it is a question whether kiln-drying would not be advantageous with us. It is a well-established fact that hops are of a better quality when dried *by currents of heated air passing rapidly through them, and not by radiation of heat.* The kiln also affords an advantage in the employment of sulphur in the process, first in its bleaching properties, which diminish the intensity of the brown color of the hops, when they are fully ripe, and secondly from the great affinity of sulphurous acid for water, in taking up the vapor in its ascent. D. J. B.

TEXTILE AND FORAGE CROPS.

THE AGRICULTURAL CAPABILITIES OF THE GREAT PLAINS.

[Condensed from a communication in the "National Intelligencer," by William Gilpin, of Independence, Missouri.]

There is a radical misapprehension in the public mind with regard to the true character of the "Great Plains" of America, as complete as that which pervaded Europe respecting the Atlantic Ocean prior to Columbus. These plains are not "deserts," but the opposite, and will in future add much to the empire of commerce and industry now being erected on this Continent. Their position and extent may be easily understood, in stating that they are comprised within the meridian line on the west side of Louisiana, the boundaries of Arkansas, Missouri, and Iowa for their eastern limit, and the Rocky Mountain crest for their western, with Texas at the south, and the Arctic coast on the north, embracing a longitudinal parallelogram of somewhat less than 1,000 miles in width. (See Pl. VI.) They have a gentle slope from the west to the east, abounding in rivers, running silently into the Missouri, Mississippi, the St. Lawrence, and to the Texan coast. They are of homogeneous formation, slightly undulating and continuous, without timbered space or lakes. The soil, though compact, is a fine calcareous mould, producing an abundance of herbage peculiarly adapted to the climate. During a temporary prevalence of moist atmosphere, in the spring, the delicate "Gramma" and "Buffalo grasses" flourish, and are cured into hay upon the ground by the gradually returning drought. It is upon this longitudinal belt of perennial pasture that the buffalo finds his winter food, subsisting upon it without regard to latitude; and here, also, are found vast numbers of wild horses, the elk, the antelope, and numerous other animals peculiar to the continent.

As the larger portion of the "Great Plains" lies within the temperate zone, their position, with respect to climate, is favorable to intellectual and physical development, health, and longevity. The seasons are comparatively rainless, except during the melting of the snows on the immense mountain masses beyond, when the rivers swell like the Nile, and yield a copious evaporation in their long courses, causing the storm-clouds to gather on the summits, roll down their flanks, and discharge themselves over the earth in vernal showers.

The atmosphere is almost perpetually brilliant with an azure sky, tonic, healthy, and inspiring to the temper, corresponding to, if not surpassing, that of the historic climates of Arabia and Syria, whence we have inherited all that is ethereal and refined in our system of civilization.

The Great Plains abound in fuel, the materials for fencing, and the construction of dwellings. Bituminous coal is abundantly interstratified with the calcareous and sandstone formations, as well as in the flanks of the mountains, and easily obtained. The dung of the buffalo is scattered everywhere, and readily burns, when dry. The order of vegetable growth, in many respects being reversed by the aridity of the atmosphere, what appear above as mere shrubs insinuate themselves deep into the earth, and form below an immense arborescent growth. Fuel of wood is therefore found by mining, or digging, instead of felling trees. Freestone, limestone, plaster, clay, and sand occur to an unlimited extent. The large and economical *adobe* brick, hardened in the sun without fire, supersedes other materials for walls and fences in these arid regions, and, as in Egypt and Syria, for centuries resist decay. The dwellings thus formed are of the most healthy kind, being impervious to heat and cold, damp and wind.

These regions embrace an ample proportion of arable soil for farms. The "bottoms" of the rivers are broad and level, being only a few inches of elevation above their waters. They may be easily and cheaply saturated by means of artificial irrigation. Under this treatment, the soils being alluvial and calcareous, both from the sulphate and carbonate formations, could be made to return a prodigious yield, independent of the fall of rain or snow. Almost every variety of grain, grass, flax, hemp, cotton, as well as vegetables, grapes, and other fruits, with the flora, under an unclouded sun, irrigated at the root, attain extraordinary vigor, flavor, and beauty; and hence this country offers a permanent home for man.

It is probable that the aggregate aboriginal stock (the buffalo, the elk, the deer, &c.) of the Great Plains still exceeds the existing number of farm quadrupeds in the settled portions of the United States. It is all spontaneously supported by Nature; and, by parity of reason, it is to be inferred that most, if not all, of our domestic animals would flourish there equally well with the indigenous ones. Three tame animals may be substituted for every wild one, and vast territories might be reoccupied, from which the aboriginal stock has been reduced by indiscriminate slaughter and the increase of wolves.

The American people, then, are about to inaugurate a new and immense order of industrial production—pastoral husbandry. Its chief theatre of action will be this *terra incognita*, intermediate between the two oceans. Once commenced, it will rapidly develop. We also anticipate here the successive inauguration and systematic growth of other distinct orders of husbandry—the culture of Cereals, hemp, tobacco, fruits—and the production of meats, leather, and wool.

Railroads and other channels for transportation by land or water will be established, connecting these regions with either sea; internal commerce will flourish, and this great pastoral garden of the world will become the happy abodes of untold millions of generations yet unborn.

D. J. B.

CHEMICAL ANALYSES OF COTTON SOILS—ANALYSES OF THE ASH OF THE COTTON PLANT.

BY CHARLES T. JACKSON, M. D., OF BOSTON.

In accordance with the instructions received by me from the Patent Office on the 29th day of July, 1857, for determining the chemical ingredients of the cotton soils and the ash of said plants, I submit the following results :

ANALYSIS OF COTTON-PRODUCING SOILS.

No. 1.

Soil from St. Simon's Island, Georgia, on which the Sea Island or Long-staple Cotton is grown.

This soil consists of a grey sand, mixed with a fine loam, containing black particles. One thousand grains of it yield to boiling distilled water $1\frac{3}{5}$ grains of soluble matter, $1\frac{1}{10}$ grains of which consist of vegetable organic matter, and half a grain of mineral salts, consisting of chloride of sodium, phosphates of lime and soda, sulphates of soda and potash, sulphate of magnesia, and carbonate of lime, which was originally a crenate of lime.

One thousand grains of this soil yield to a boiling solution of carbonate of ammonia $3\frac{3}{5}$ grains of solid matter, two-fifths of a grain of which consist of mineral salts, as above named.

The insoluble carbonaceous matters amounted to 24 grains to 1,000, or $2\frac{2}{5}$ per cent.

On full analysis, I obtained from this soil—

Silica	92.040	per cent.
Alumina	1.500	"
Lime	0.280	"
Magnesia	0.370	"
Potash	1.000	"
Soda	0.500	"

Peroxyde of iron and oxyde manganese	1.500	per cent.
Phosphoric acid	0.040	"
Sulphuric acid	0.009	"
Chlorine	0.010	"
Crenic, apocrenic and humic acids	0.360	"
Insoluble vegetable (carbonaceous) matter	2.400	"
Carbonic acid	trace.	
	100.009	"

Analysis of the ash of Sea Island or Long-staple Cotton, from St. Simon's Island, as above.

The stalk of this plant, stripped of its leaves and bolls, when burned, yielded 107 grains of ashes. The leaves, burned, yielded $107\frac{1}{2}$ grains of ashes; and the cotton fibre yielded, when burned, 13 grains to 1,000. One thousand grains of the seeds, when burned, yielded $36\frac{3}{5}$ grains of ashes.

Twenty-five grains of the ashes from the stalks yielded—

Silica	0.600	grains.
Carbonic acid	6.000	"
Chlorine	0.198	"
Sulphuric acid	0.480	"
Phosphoric acid	3.969	"
Lime	7.059	"
Magnesia	0.183	"
Potash	3.802	"
Soda	1.744	"
	24.035	"
Loss	0.965	"
	25.000	"

Twenty-five grains of the ashes of the leaves yielded—

Silica	1.200	grains.
Carbonic acid	4.959	"
Chlorine	0.667	"
Sulphuric acid	1.271	"
Phosphoric acid	4.864	"
Lime	6.978	"
Magnesia	0.350	"
Potash	2.922	"
Soda	1.789	"
	25.000	"

One thousand grains of the clear cotton fibre, yielding 13.1 grains of ashes, gave—

Silica	0.60	grains.
Carbonic acid	2.80	"
Chlorine	0.30	"
Sulphuric acid	0.54	"
Phosphoric acid	1.64	"
Lime	1.80	"
Magnesia	0.64	"
Potash	2.79	"
Soda	1.90	"
	13.10	"

One thousand grains of the seeds yielded $36\frac{3}{5}$ grains of ashes, which consist of—

Silica	0.1000	grains.
Carbonic acid (diff.)	0.3504	"
Chlorine	0.3940	"
Sulphuric acid	0.0980	"
Phosphoric acid	11.3618	"
Lime	1.7484	"
Magnesia	6,0838	"
Potash	13,3566	"
Soda	3.1070	"
	36.6000	"

No. 2.

Upper alluvial soil of Savannah River, on which the Short-staple Cotton grows, in Edgefield, South Carolina.

This soil yields upon analysis—

Silica	78.000	per cent.
Alumina	10.040	"
Lime	0.260	"
Magnesia	0.200	"
Potash	1.000	"
Soda	0.730	"
Peroxyde of iron and oxyde manganese	4.850	"
Phosphoric acid	0.310	"
Sulphuric acid	trace.	
Chlorine	0.050	"
Crenic, apocrenic and humic acids	0.400	"
Insoluble vegetable matter	4,300	"
	100.140	"

One thousand grains of this soil, digested with a solutiou of carbonate of ammonia, yield $4\frac{9}{10}$ grains of soluble matter, 4 grains of which consist of the organic acids of the soil, namely, crenic, apocrenic and humic acids, and nine-tenths of a grain consist of mineral matters—phosphate of lime, sulphate of lime, magnesia, oxyde of iron, and the alkalies, soda, potash, and a little silica.

This soil has for its mineral constituents the disintegrated matters from the metamorphic rocks, chiefly micaceous and argillaceous slate rocks, the particles of mica being unusually abundant, but the argillaceous matters in a finely decomposed state, or in the condition of clay.

No. 3.

Upland Cotton soil, from near Jackson, Mississippi, the samples obtained from the surface to the depth of 10 *inches.*

This soil is very fine loam, and, when dry, is almost an impalpable dust.

One hundred grains of it on analysis yielded—

Silica	81.00	per cent.
Alumina	6.80	"
Lime	0.57	"
Magnesia	1.60	"
Potash	0.58	"
Soda	1.29	"
Peroxydes of iron and manganese	4.18	"
Phosphoric acid	0.38	"
Sulphuric acid	0.07	"
Chlorine	0.05	"
Crenic, apocrenic and humic acids	0.30	"
Insoluble vegetable matter	3.00	"
	99.82	"
Loss	0.18	"
	100.00	

The sub-soil of the above, obtained 20 *inches below the surface, yielded*—

Silica	83.451	per cent.
Alumina	4.100	"
Lime	0.500	"
Magnesia	1.800	"
Potash	0.790	"
Soda	1.450	"
Peroxydes of iron and manganese	3.900	"

Phosphoric acid	0.190	per cent.
Sulphuric acid	0.014	"
Chlorine	0.005	"
Crenic, apocrenic and humic acids	0.410	"
Insoluble vegetable matter	3.000	"
	99.610	"
Loss	0.390	"
	100.000	"

No. 4.

Surface soil from Samuel Wood's *plantation, in Hancock county, Mississippi.*

One hundred parts by weight of this soil yielded—

Silica	88.52	per cent.
Alumina	1.20	"
Lime	0.40	"
Magnesia	0.50	"
Potash	0.38	"
Soda	1.00	"
Peroxydes of iron and manganese	2.00	"
Phosphoric acid	0.60	"
Sulphuric acid, (less than $\frac{1}{1000}$,)	trace.	"
Chlorine	trace.	"
Crenic, apocrenic and humic acids	0.92	"
Carbonic acid	0.20	"
Insoluble vegetable matter	4.33	"
	100.05	"

One thousand grains of this soil yielded to boiling distilled water 2 grains of soluble matter, or one-fifth of one per cent., and this, on incineration, yielded half a grain of ash, or five-hundredths of 1 per cent. The ash consists of phosphate of lime, magnesia, oxyde of iron, sulphate of lime, and the alkalies, potash, and soda.

Digested in a solution of carbonate of ammonia, 1,000 grains of the soil produce a dark coffee-brown solution, which, evaporated to dryness, yields 10 grains of solid matter, consisting of the organic acids of the soil, namely, crenic, apocrenic and humic acids; and on being burned off, this matter yields four-fifths of a grain of ash, consisting of the mineral salts which were combined with the above-named acids. The organic acids weigh $9\frac{1}{5}$ grains, or ninety-two-hundredths of 1 per cent., and the ashes, or mineral salts, eight-hundredths of 1 per cent.

One hundred grains of the sub-soil yield on analysis—

Silica	90.000	per cent.
Alumina	2.000	"
Lime	0.280	"
Magnesia	0.300	"
Potash	0.290	"
Soda	2.014	"
Peroxydes of iron and manganese	1.200	"
Phosphoric acid	0.800	"
Sulphuric acid	0.007	"
Chlorine	0.005	"
Crenic, apocrenic and humic acids	1.020	"
Insoluble vegetable matter	2.790	"
	100.716	"

One thousand grains of this sub-soil, on digestion with a solution of carbonate of ammonia, at a boiling heat, yield $12\frac{1}{5}$ grains of soluble organic matter and salts; and, on combustion, 2 grains of saline or mineral matter remain, leaving for organic matters dissolved $12\frac{1}{5}$ grains. The ash contains phosphate of lime, sulphate of lime, soda, potash, and chlorine.

From the composition of this sub-soil, it will appear that deep, or sub-soil, ploughing is indicated as appropriate for this plantation; for the sub-soil is richer in certain important ingredients than the surface soil, as will be seen on comparing the proportions of soda and of phosphoric acid.

Analysis of the ash of a Long Staple (Sea Island) Cotton plant taken from the same soil as above.

The stalk of this plant, weighing 13 ounces, on being burned, yielded 133 grains of ashes, which consist of, in 25 grains of the ash—

Silica	1.150	grains.
Carbonic acid	5.600	"
Chlorine	0.603	"
Sulphuric acid	0.412	"
Phosphoric acid	2.739	"
Lime	6.254	"
Magnesia	1.100	"
Potash	2.851	"
Soda	3.351	"
Peroxyde of iron	0.940	"
	25.000	"

The dry leaves, weighing $7\frac{1}{2}$ ounces, on being burned, yielded 306 grains of ashes, and 25 grains of this ash gave, on analysis—

Silica	1.540	grains.
Carbonic acid	3.800	"
Chlorine	2.220	"
Sulphuric acid	1.065	"
Phosphoric acid	2.795	"
Lime	7.275	"
Magnesia	0.200	"
Potash	3.522	"
Soda	1.908	"
Peroxyde of iron	0.675	"
	25.000	"

One thousand grains of the fibre, or clean cotton, yielded 15 grains of ashes, which consist of—

Silica	0.240	grains.
Carbonic acid	3.500	"
Chlorine	1.100	"
Sulphuric acid	0.824	"
Phosphoric acid	1.733	"
Lime	2.641	"
Magnesia	0.200	"
Potash	3.628	"
Soda	0.974	"
Carbon, (not burned,)	0.230	"
	15.070	"

One thousand grains of the seeds yielded $41\frac{1}{5}$ grains of ashes, which consist of—

Silica	0.160	grains.
Carbonic acid	1.200	"
Chlorine	0.430	"
Sulphuric acid	0.872	"
Phosphoric acid	10.640	"
Lime	1.850	"
Magnesia	7.860	"
Potash	12.340	"
Soda	4.472	"
Loss	1.376	"
	41.200	"

Analysis of ashes of Short-staple Cotton, from Hamburg, South Carolina.

One thousand grains of the clean cotton fibre, burned, yielded 15 grains of ashes, which consist of—

	Grains.
Silica	0.150
Carbonic acid	4.100
Chlorine	1.105
Sulphuric acid	0.779
Phosphoric acid	0.581
Lime	1.070
Magnesia	0.250
Potash	4.412
Soda	2.140
	14.587
Loss	0.413
	15.000

One thousand grains of the seeds yielded 39 grains of ashes, which consist of—

	Grains.
Silica	0.080
Carbonic acid (diff.)	1.018
Chlorine	0.480
Sulphuric acid	0.892
Phosphoric acid	10.690
Lime	1.126
Magnesia	7.600
Potash	13.096
Soda	4.018
	39.000

Analysis of the seeds of a Short-staple Cotton plant, from Jackson, Mississippi

One thousand grains of the seed, burned, yielded 28 grains of ashes, which consist of—

	Grains.
Silica	0.260
Carbonic acid	1.000
Chlorine	0.260
Sulphuric acid	0.240
Phosphoric acid	7.648
Lime	1.122
Magnesia	5.032
Potash	7.276
Soda	4.962
	27.800
Loss	0.200
	28.000

Analysis of the ashes of the entire plants of Upland or Short-staple Cotton, from Savannah River, Georgia.

The whole plants, which weighed 3 pounds, when dried, yielded, on burning, 960 grains of ashes, 25 grains of which were resolved into—

	Grains.
Silica	0.570
Carbonic acid	5.600
Chlorine	0.239
Sulphuric acid	0.927
Phosphoric acid	2.403
Lime	4.478
Magnesia	2.509
Potash and soda (diff.)	6.394
Peroxyde of iron	1.880
	25.000

REMARKS.—By these analyses, we learn the nature and proportions of the mineral ingredients which the different parts of the cotton plants draw from the soil, and which must be present in the soil to render it capable of producing this crop.

Now, since the seeds weigh nearly four times as much as the cotton fibre in each plant, it is evident that, as they are very rich in saline matters, phosphates of magnesia and lime, and in the alkalies, potash and soda, they form one of the most valuable fertilizers to return to the soil. If the seed be sold and sent away for the manufacture of oil, the oil-cake, still containing all the saline matters, may be returned as a manure for cotton-fields, and it will be found to be one of the best fertilizers, not only for that crop, but also for corn, which requires a large supply of the phosphates and alkalies.

It does not appear by these analyses that Sea Island or Long-staple Cotton plants appropriate any more chlorine or chloride of sodium than the short-stapled varieties; and it seems probable that atmospheric influences on the humid sea-board favor the growth of the long-stapled cottons, and that the saline matters in the soil do not produce the difference by their absorption into the plants.

THE COTTON MANUFACTURES OF THE UNITED STATES.

The social and political relations of man are mainly formed and controlled through the influence of industry applied to the production of material wealth. That "bread is the staff of life," that "coal and iron govern the world," and that "cotton is king," are proverbs expressive of the prominence of these commodities among the things supplied for the convenience and comfort of the human family. But the degree of influence exerted by a particular product can only be appreciated by a consideration of all its relations, including a knowledge of the dependence upon each other of the different branches of industry and production, often involving minute and complex investigations.

The superiority of the present era is most strikingly exemplified by a review of its achievements in physical science with respect to the gratification of our material wants, whether in the department of agriculture, the mechanic arts, locomotion upon land and water, applied chemistry, or other utilitarian pursuits. In an age less favored in regard to those things which minister to the welfare of the many, an elevation not yet accessible to us was attained with respect to eloquence, poetry, painting, sculpture, architecture, and the humanities in general. Without purposing to discourage these high and ennobling objects of pursuit, essential as they are to the happiness and exaltation of our race, the inventive genius, enterprise, and industry of the present age may be indicated at once as the cause and the effect of the general and continued advancement of the world. Thus, the aliment of man formerly consisted almost exclusively of the Cereals and fruits; but, it has been affirmed, if all men were now confined to this description of food, the soil of many countries would not be sufficient for its growth. The policy, or necessity, is therefore manifest, of cultivating other plants, and especially that nutritious and economical esculent, the potato, aided by all the improvements of the times with respect to systematic tillage, including the use of modern implements, manures, rotation of crops, &c., by means of which labor as well as land is spared from the production of food, and devoted to the culture of other substances.

What the potato has thus proved among esculents, cotton has been found among textiles, in the gratification of an imperative and general demand.

The development of coal for fuel, of infinitely greater value in its concentrated form than the forests present, is another step in the march of improvement, not only as it contributes to our comfort in the warmth it affords to our bodies, but in its relation as a valued servant in the propulsion of machinery and engines of locomotion. It thus forms the basis of the steam-engine, without which, admitting the mechanical practicability, civilized Europe could not sustain the number of men requisite to produce a power equal to that it now

exerts; but this could never have been achieved but for the progress of the manufacture of iron, which, in turn, is an essential medium in the operation of the electric telegraph, of the printing press, and a thousand other important agencies, supplying to enlightened man the means of going forth as the triumphant champion of civilization. The useful arts are in these, and shown necessarily to sustain relations of mutual dependence upon each other, when viewed in their direct physical effects, if any one remains behind, all uniting in efforts to raise it to their level and requirements. Allied to this idea is that of the division of labor and the co-operation of the different nations of the earth in purposes of beneficent enterprise, of which the ancients had but faint conceptions. These agencies shall still progress, and in their influences dissipate the restrictions and the seclusion of nations, and establish forever the civilization of the present era. The cultivator of the cotton-plant thus fulfills an important mission with respect to political economy and the history of our race, aided as he is by the shipper who carries the product to other lands; by the spinner who transforms it into yarn; by the weaver who converts it into cloth and other fabrics; and by all the agents who contribute to these results. Thus, in the sphere of creation all things exert an influence, circling wide beyond their seeming import, and the principle of self.

Cotton employs millions of the human family in its culture, commerce, and manufacture, and indirectly as many who produce the articles required for the sustenance of those first so engaged. It partially supplies raiment and other comforts to the entire civilized world; yet, in so doing, seems as a substitute for a vast quantity of silk, wool, flax, and hemp in the markets of the world, and consequently to some extent directs from their former channels the capital and industry requisite for the production of these fabrics to the extent to which they are superseded. Such being the general influences upon the world of the culture of cotton, it is reasonable that every nation should desire to profit by it.

The usual estimate of the consumption of cotton in the United States and England is from 5 to 6 pounds for each person; and in France, from 4 to $4\frac{1}{2}$ pounds. Mr. Bowring, in his Report on the German Zollverein, states the consumption at $4\frac{7}{20}$ pounds to each family, (or less than a pound to each person,) but this is certainly below the present distributive amount. Doctor Dieterici, of the Statistical Bureau of Berlin, estimated the consumption in Prussia, in 1806, at $\frac{3}{4}$ of a yard; in 1841, at 7 yards; and in 1844, at 13 yards; but it is now believed to amount to from 24 to 30 yards, or about 3 pounds. In Turkey and the adjacent countries the consumption is estimated at from 2 to $2\frac{1}{2}$ pounds for each person. With respect to India and China, our knowledge is less certain. Mr. Royle, in his excellent work on "The Culture and Commerce of Cotton in India," informs us that some observers estimate the consumption in British India at 20 pounds to each individual, the aggregate consumption at 3,000,000,000 pounds, and the crop at 3,100,000,000. He questions the correctness of this estimate; but the cotton produced there is

different in quality, unclean and badly prepared for the loom, and woven into inferior fabrics which are used for more varied purposes than cotton cloth is applied to in other parts of the world, including not only the clothes and robes of the people, but their beds and bedding, tents, cords, bands, and almost every purpose to which a textile material of such softness and flexibility is possibly adapted. The importance of this product to the people who there cultivate and consume it is unquestionably great. In fact, we cannot comprehend how what appear to be their absolute wants could be gratified without it. While it supplies their own requirements, however, in their present condition, it makes but little impression upon the general commerce of mankind. In this respect, the product of the United States, where its extended culture does not date a century back, is of the first importance, though the experiments of the English in British India were commenced a century earlier, and though the history of the culture of the plant in Asiatic countries runs through thousands of years. No branch of industry probably ever rose to such magnitude in so brief a time. Producing a very large annual supply above the actual wants of the country, and of a material superior in quality to the yield of any other land, the United States possesses by virtue of this crop an interest in the commerce of the world which could not be secured by means of a product less peculiar in its nature, or less intimately connected with the social condition of civilized Europe. This cotton chain not only binds one section of our land to the other, but unites England to us

"With links more durable than links of steel."

English and American fabrics made from our cotton are known over the whole globe, and in the markets of China and India take precedence of the products of the indigenous staple, in some fabrics, not only because they are better, but because they can be purchased even there at lower prices. Thus, this improved product of the soil in America, aided by the inventions of Arkwright, Watt, and Whitney, is even now more powerful than armies in securing the advancement of civilization and enlightened liberty. These influences are yet to increase as the demand for cotton is augmented. There must be more soil devoted to its culture, or that already under tillage must be improved in fertility. More laborers must bend to the work or the industry now so applied must be rendered more productive. And none of these changes can be accomplished without visible effects upon the social and political affairs of mankind.

The following tables show the amount and valuation of cotton consumed in the United States during the fiscal year ending June 30, 1857, and the character, quantity, and valuations of the goods manufactured therefrom, as far as returns have been made.

D. J. B.

Table showing the amount and valuation of cotton consumed in the United States, &c.

	COTTON CONSUMED.		GOODS MANUFACTURED.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
ALABAMA.					
AUTAUGAVILLE.					
Planters' Factory	lbs. 599,482	$75,634	Linseys.....yds..	14,053	$4,637
			Osnaburgs.....yds..	1,017,892	117,058
			Thread.....lbs..	13,614	2,450
PRATTVILLE.					
Manufacturing Co. No. 1	666,680	73,833	Osnaburgs.....yds..	1,115,186	119,713
SCOTTSVILLE.					
Tuscaloosa Manufacturing Co.	312,000	34,320	Batting.....lbs..	.....	.....
			Linseys.....yds..	10,000	3,000
			Mattresses.....lbs..	.....	.....
			Osnaburgs.....yds..	400,000	48,000
			Thread.....lbs..	250	.....
			Yarn.....lbs..	75,000	15,000
CONNECTICUT.					
HARTFORD.					
D. B. Smith & Co.	52,000	84,400	.....	.....	.....
Union Manufacturing Co.	450,000	63,000	Ginghams.....yds..	2,000,000	2,000,000
LISBON.					
John Bachelder	517,500	62,100	Seamless bags.....No..	450,000	103,500
MIDDLETOWN.					
Falls Manufacturing Co. } Russell Manufacturing Co. }	300,000	36,000	Webbing suspenders &c.....	.....	250,000
			Thread.....lbs..	100,000	27,000
NORWICH.					
Falls Co.	1,782,064	233,997	Denims, drills, stripes, ticks.....yds..	5,807,670	450,000
Shetucket Co.	1,451,000	186,000	Cottonades.....yds..	230,000	} 376,000
			Denims.....yds..	844,000	
			Drills.....yds..	84,000	
			Stripes.....yds..	2,275,000	
			Ticks.....yds.	779,000	
PAYNONOCK.					
Harris Brothers	83,200	11,648	Print cloths.....yds..	665,600	33,280
PLAINFIELD.					
Waurigan Mills	428,804	58,960	Print cloths.....yds..	583,788	26,216
			Sheeting and shirting.yds..	368,205	25,566
			Sheeting and shirting, bleached.....yds..	736,412	51,132
Central Co.	299,273	42,164	Sheeting.....yds..	159,238	12,739
			Printing cloths.....yds..	1,412,908	79,129
PLAINVILLE.					
Plainville Manufacturing Co.	150,000	21,000	Under garments.....doz..	15,600	140,400
STAFFORD SPRINGS.					
Granite Mills	193,936	27,151	Batting.....lbs..	9,000	900
			Sheeting and shirting..yds..	101,000	60,600

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	Cotton consumed.		Goods manufactured.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
CONNECTICUT—Continued.					
STIRLING.					
Stirling Mills	lbs. 98,800	$13,910	Sheeting and shirting..yds..	451,000	$30,000
THOMPSON.					
Masonville Co	364,000	47,320	Sheeting and shirting..yds..	1,100,000	120,000
VERNON DEPÔT.					
Centreville Co	340,000	47,600	Bags..lbs..	300,000	67,500
WEST THOMPSON.					
Walker & Sharpe	100,000	13,000	Sheeting and shirting..yds..	500,000	20,000
WILLIMANTIC.					
Smithville Manufacturing Co	347,330	55,572	Print cloths..yds..	931,954	41,938
			Sheeting..yds..	834,570	66,765
Windham Cotton Manufact'g Co.	497,223	69,000	Print cloths..yds..	1,753,198	105,192
			Sheeting and shirting..yds..	680,497	54,440
Willimantic Duck Manufact'g Co.	362,045	40,277	Bags..No..	72,830	14,566
			Duck..yds..	265,286	67,623
Cotton Sail Twine Co	100,000	14,000	Cotton sail twine..lbs..	90,000	22,500
DELAWARE.					
WILMINGTON.					
Brandywine Cotton Mills	520,000	79,300	Ticks..yds..	1,560,000	124,800
Rockford Cotton Factory	146,300	21,000	Drills..yds..	15,348	1,534
			Sheeting and shirting..yds..	247,164	22,244
			Other goods..yds..	209,944	17,845
MARYLAND.					
BALTIMORE.					
Warren Factory	280,000	37,800	Drills..yds..	143,229	12,932
			Sheeting and shirting..yds..	719,023	50,331
MISSISSIPPI.					
BANKSTON.					
Mississippi Manufacturing Co	135,000	13,850	Linseys..yds..	208,800	58,460
			Osnaburgs..yds..	70,000	8,750
			Yarn..lbs..	4,500	900
MASSACHUSETTS.					
ADAMS.					
Thomas A. Brayton	113,700	16,000	Print cloths..yds..	675,000	37,125
BLACKSTONE.					
Blackstone Manufacturing Co.	1,834,697	256,857	Print cloths..yds..	4,199,838	251,990
			Sheeting and shirting..yds..	3,145,510	347,006
CHICOPEE.					
Dwight Manufacturing Co	4,295,742	527,037	Drills..yds..	3,224,728	275,000
			Print cloths..yds..	1,498,441	90,500
			Sheeting and shirting..yds..	8,897,539	734,500
Chicopee Manufacturing Co	2,707,811	326,755	Drills..yds..	2,574,830	231,735
			Jeans..yds..	1,544,810	123,585
			Print cloths..yds..	1,031,955	61,917
			Sheeting and shirting..yds..	2,332,684	209,941

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	COTTON CONSUMED.		GOODS MANUFACTURED.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
MASSACHUSETTS—Continued.					
LINTON.					
Clinton Co.	lbs. 276,200	$34,772	Ginghams ... yds..	1,112,727	$111,272
Lancaster Mills	900,000	126,000	Ginghams ... yds..	5,000,000	550,000
COLERAIN.					
Shattuck & Whitton	150,000	18,500	Sheeting ... yds..	450,000	32,500
			Print cloths ... yds..	600,000	24,000
DEDHAM.					
Dedham Manufacturing Co.	109,894	15,385	Print cloths ... yds..	568,178	28,409
Norfolk Manufacturing Co.	122,909	17,207	Print cloths ... yds..	676,000	33,800
EAST BROOKFIELD.					
Brookfield Manufacturing Co.	312,000	37,440	Denims ... yds..	90,000	9,000
EASTON.					
Keith, Rotch & Co.	13,250	5,470	Batting ... lbs..	2,000	220
			Thread ... lbs..	10,400	10,500
Amos Pratt & Co.	20,800	2,912	Thread ... lbs..	18,997	10,448
FALL RIVER.					
Metacomet Mills	1,068,344	138,525	Print cloths ... yds..	5,511,000	306,856
Annawan Manufactory	290,839	38,146	Print cloths ... yds..	1,505,736	89,591
Fall River Manufactory	334,168	41,120	Print cloths ... yds..	1,675,333	95,513
American Print Works	2,167,000	303,380	Prints ... yds..	12,457,692	1,058,904
FISKDALE.					
Strawbridge Cotton Mills	397,163	51,631	Print cloths ... yds..	2,121,600	127,296
GRAFTON.					
Saunders' Cotton Mills	357,365	53,447	Print cloths ... yds..	1,911,401	107,038
GREAT BARRINGTON.					
Monument Mills	120,000	20,000	Warp ... yds..	106,000	31,000
HAYDENVILLE.					
Hayden Manufacturing Co.	25,000	3,000	Sheeting and shirting.. yds..	900,000	75,000
HOLYOKE.					
Hampden Mills	592,186	76,516	Cottonades ... yds..	1,785,054	290,964
Lyman Mills	3,876,381	478,197	Print cloths ... yds..	3,922,984	292,654
			Sheeting and shirting.. yds..	8,110,547	640,732
LAWRENCE.					
Atlantic Cotton Mills	5,650,000	...	Print cloths ... yds..	3,700,000	222,000
			Sheeting ... yds..	10,500,000	945,000
			Shirting ... yds..	1,800,000	108,000
Pemberton Mills	278,420	361,946	Cottonades ... yds..	832,560	240,060
			Denims ... yds..	927,766	129,887
			Flannels ... yds..	245,648	24,565
			Ginghams ... yds..	196,370	39,314
			Stripes ... yds..	162,804	17,908
			Ticks ... yds..	3,355,266	469,737
LONG PLAIN.			Yarn ... lbs..	60,000	15,000
Allen's Manufactory	42,242	6,336	Wick ... lbs..	36,000	7,3[illegible]0

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	COTTON CONSUMED.		GOODS MANUFACTURED.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
MASSACHUSETTS—Continued.					
LOWELL.					
Appleton Co	lbs. 3,477,400	$372,625	Sheeting and shirting..yds..	8,369,685	$696,107
Booth Cotton Mills	4,200,000	525,000	Drills..yds..	6,167,000	493,360
			Print cloths..yds..	2,037,000	122,220
			Sheeting and shirting..yds..	4,409,000	341,697
Hamilton Manufacturing Co	4,149,347	441,341	Flannels..yds..	3,812,808	381,281
			Prints..yds..	5,065,222	481,196
			Sheeting and shirting..yds..	210,265	70,096
			Ticks..yds..	2,075,855	249,102
Lawrence Manufacturing Co	7,473,688	1,001,474	Drills..yds..	2,971,943	220,615
			Sheeting and shirting..yds..	14,220,839	1,001,915
Lowell Manufacturing Co	2,861,877	307,337	Carpets..yds..	102,503	48,689
			Linseys..yds..	201,731	34,271
			Osnaburgs..yds..	4,208,453	403,096
Massachusetts Cotton Mills	9,343,169	1,167,896	Drills..yds..	6,670,877	567,024
			Sheeting and shirting..yds..	20,062,276	1,334,141
Merrimack Manufacturing Co	4,521,257	474,121	Prints..yds..	17,493,066	1,570,375
			Sheeting and shirting..yds..	2,277,840	170,838
			Twine..lbs..	23,761	7,390
Tremont Mills	3,327,639	40,091	Sheeting and shirting..yds..	10,996,090	659,765
Suffolk Manufacturing Co	3,248,202	390,948	Drills..yds..	7,773,681	621,894
METHUEN.					
Methuen Co	558,090	60,027	Denims..yds..	33,125	3,643
			Duck..yds..	402,956	40,295
			Ticks..yds..	583,686	64,205
			Yarn..lbs..	500	75
NEWBURYPORT.					
Bartlett Steam Mills	600,000	84,000	Sheeting and shirting..yds..	2,000,000	180,000
Globe Steam Mills	1,181,365	153,577	Flannels..yds..	234,129	28,094
			Jeans..yds..	3,105,622	279,506
			Print cloths..yds..	299,731	16,485
James' Steam Mills	613,394	77,112	Sheeting and shirting..yds..	2,185,474	173,308
Ocean Steam Mills	364,370	48,344	Print cloths..yds..	1,880,711	89,657
NEWTON UPPER FALLS.					
Newton Mills	457,759	73,241	Print cloths..yds..	2,359,715	129,784
NORTON.					
Wheaton Manufacturing Co	127,077	18,547	Shirting..yds..	417,882	37,609
NEW BEDFORD.					
Wamsutta Mills	1,135,058	147,557	Sheeting and shirting..yds..	3,120,000	468,000
NORTH OXFORD.					
Protection Mills } New Mills } Phœnix and Rockdale Mills }	728,000	87,360	Sheeting and shirting..yds..	1,508,000	113,100
			Twine..lbs..	5,250	892
NORTH SUNDERLAND.					
T. G. Munsell	4,000	4,400	Wick..lbs..	36,000	6,480

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	COTTON CONSUMED.		GOODS MANUFACTURED.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
MASSACHUSETTS—Continued.					
NORTH UXBRIDGE.					
Uxbridge Cotton Mills............	lbs. 434,210	$60,522	Sheeting and shirting..yds..	1,664,251	$133,140
NORTHAMPTON.					
Greenville Manufacturing Co ...	177,000	22,000	Miscellaneous........yds..	700,000	42,000
OAKDALE.					
West Boylston Manufacturing Co.	451,000	63,140	Flannels ....yds..	572,000	46,000
			Brown sheeting.......yds..	750,000	62,000
PITTSFIELD.					
Plunkett, Clapp & Co...........	95,000	133,000	Wadding ....lbs..	250,000	50,000
E. & J. A. Peck................	....	....	Sheeting and shirting. yds..	1,450,000	100,000
S. N. & C. Russell	....	....	Satinet warp..........lbs..	200,000	50,000
ROCKVILLE.					
Boyd & Walker	22,350	3,687	Thread ....lbs..	20,048	9,469
			Wadding ....lbs..	158,358	29,904
SHARON.					
Geo. R. & Wm. R. Mann	115,000	16,100	Duck ....yds..	55,050	26,067
SOUTHBRIDGE.					
Central Manufacturing Co.......	425,000	58,437	Sheetings ....yds..	1,700,000	102,000
SOUTH HADLEY.					
South Hadley Mills..............	550,000	....	Ginghams ....yds..	2,800,000	....
TAUNTON.					
Albros & Anthony	411,059	47,843	Jeans ....yds..	1,558,810	100,937
WALTHAM.					
Boston Manufacturing Co........	1,600,000	212,000	Sheeting and shirting..yds..	4,057,737	369,807
WARE.					
Otis Company	2,081,179	286,162	Denims ....yds..	5,922,961	592,296
WARREN.					
Knowles & Sibley..........	90,000	12,600	Satinets..............yds..	65,000	32,500
			Warp ... .lbs..	88,750	28,400
Warren Cotton Mills...........	600,000	68,000	Denims ....yds..	1,500,000	150,000
MAINE.					
AUGUSTA.					
Kennebec Co.	875,130	111,128	Sheeting and shirting..yds..	3,371,853	202,311
BIDDEFORD.					
Pepperell Manufacturing Co	5,030,912	598,678	Drills ....yds..	2,968,860	209,616
			Flannels ....yds..	400,676	37,733
			Jeans ....yds..	1,173,838	90,647
			Sheeting and shirting..yds..	8,761,231	682,641
HALLOWELL.					
Hallowell Cotton Manufact'g Co.	364,000	44,000	Print cloths ....yds..	2,000,000	115,000

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	Cotton consumed.		Goods manufactured.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
MAINE—Continued.					
LEWISTON.					
Hill Manufacturing Co.	lbs. 805,519	$106,468	Print cloths ....yds..	65,027	$3,901
			Sheeting and shirting..yds..	2,778,989	233,785
Lincoln Mills	375,076	52,041	Jeans ....yds.	1,400,000	112,000
Bates Manufacturing Co.	2,040,911	262,948	Flannels ....yds..	268,562	....
			Jeans ....yds..	1,672,144	....
			Pant stuffs ....yds..	711,990	....
			Sheeting and shirting..yds..	3,084,197	....
SACCARAPPA.					
Saccarappa Manufacturing Co.	96,545	14,000	Print cloths ....yds..	523,496	24,866
SACO.					
York Manufacturing Co.	2,531,377	286,309	Denims ....yds..	318,374	40,774
			Drills ....yds..	1,348,559	94,730
			Nankin ....yds..	653,184	51,889
			Stripes..............yds..	208,804	18,870
			Ticks ....yds..	237,426	25,921
			Fancy plaids and pantaloonery ....yds..	3,403,408	409,408
SOUTH BERWICK.					
Portsmouth Company	1,084,506	131,523	Sheeting and shirting..yds..	2,487,675	186,221
WESTBROOK.					
Portland Manufacturing Co.	648,425	82,517	Duck ....yds..	129,960	27,422
			Stripes .... yds..	1,304,618	117,415
NEW JERSEY					
GROVEVILLE.					
Brinckle & Shubrick	418,600	60,697	Batting ....lbs..	5,145	563
			Warp and yarn ....lbs..	364,000	92,820
MILLVILLE.					
Wood, Star & Garrett	450,000	63,000	Sheeting and shirting..yds..	1,671,940	167,194
NEW PROSPECT.					
Hohokus Bergen Co.	468,000	60,840	Warp ....lbs..	290,000	67,000
			Yarn ....lbs..	89,000	16,000
E. Rosencrantz	171,600	22,308	Warp.................lbs..	124,800	29,852
			Yarn ....lbs..	26,000	15,600
RALSONVILLE.					
Crane & Renouf	30,000	3,000	Batting .... lbs..	20,000	3,000
			Mattrasses............lbs..	500	100
			Carpet warp.........lbs..	10,000	1,800
NEW HAMPSHIRE.					
CAMPTON VILLAGE.					
E. Doll & Co.	2,645	390	Mixed goods................	....	....
CHESTERFIELD.					
Chesterfield Factory	50,000	6,500	Sheeting..............yds..	140,400	9,828

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	COTTON CONSUMED.		GOODS MANUFACTURED.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
NEW HAMPSHIRE—Continued.					
CLAREMONT.					
Monadnock Mills	lbs. 800,000	$100,000	Drills..........yds..	40,000	$320,000
			Sheeting and shirting..yds..	572,000	126,000
DOVER.					
Cocheco Manufacturing Co.	2,058,555	224,797	Print cloths..........yds..	9,862,725	552,312
EAST JEFFREY.					
A. Bascom & Co	320,580	40,258	Denims..........yds..	801,861	92,111
EXETER.					
Exeter Manufacturing Co.	454,822	63,600	....	....	....
HOOKSETT.					
Amoskeag Manufacturing Co.	256,279	33,831	Print cloths..........yds..	1,411,100	70,555
LACONIA.					
Belknap Mill	212,565	27,633	Bags..........lbs..	157,462	37,822
MANCHESTER.					
Amoskeag Manufacturing Co.	8,918,458	1,068,013	Denims..........yds..	2,112,983	241,518
			Drills..........yds..	4,571,443	337,223
			Flannels..........yds..	1,497,356	132,670
			Jeans..........yds..	638,941	56,115
			Print cloths..........yds..	278,803	14,434
			Sheeting and shirting..yds..	5,980,339	470,541
Manchester Print Works	798,437	115,569	Miscellaneous..........yds..	23,124,320	511,731
Stark Mills	7,087,827	789,557	Bags..........lbs..	2,273,256	477,473
			Drills..........yds..	2,968,047	221,120
			Duck..........yds..	202,232	46,513
			Sheeting and shirting..yds..	6,068,944	419,818
MASON VILLAGE.					
Columbian Manufacturing Co.	1,458,000	233,280	Denims..........yds..	3,647,000	328,230
NASHUA.					
Nashua Manufacturing Co.	3,835,594	447,599	Drills..........yds..	473,736	33,461
			Flannels..........yds..	1,311,302	93,440
			Jeans..........yds..	114,943	7,528
			Print cloths..........yds..	512,820	23,588
			Shirtings..........yds..	422,977	23,432
			Sheetings..........yds..	6,665,326	441,165
			Silesias..........yds..	972,208	51,561
Jackson Co.	3,023,956	330,000	Sheeting and shirting..yds..	7,419,233	593,538
NEW MARKET.					
New Market Manufacturing Co.	1,608,472	194,295	....	....	....
PITTSFIELD.					
Pittsfield Manufacturing Co.	670,000	110,550	Sheeting and shirting..yds..	1,924,000	144,300
PORTSMOUTH.					
Portsmouth Steam Factory	380,332	58,117	Lawns..........yds..	3,301,678	200,000

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	Cotton consumed.		Goods manufactured.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
NEW HAMPSHIRE—Continued.					
ROLLINGSFORD.					
Salmon Falls Manufacturing Co..	lbs. 5,200,000	$702,000	Drills..................yds..	5,500,000	$440,000
			Flannels..............yds..	500,000	50,000
			Sheeting .... .yds..	5,500,000	440,000
SOMERSWORTH.					
Great Falls Manufacturing Co....	5,230,884	610,338	Drills........ ...yds..	2,033,506	158,581
			Print cloths...........yds..	4,152,067	233,129
			Sheeting and shirting, brown..............yds..	5,603,090	426,563
			Sheeting and shirting, bleached ....yds..	6,890,665	531,895
UPPER GILMANTON.					
Tioga Manufacturing Co....	300,000	42,000	Warp ....lbs..	105,000	21,000
			Wicks ....lbs..	150,000	30,000
NEW YORK.					
BRAINARD.					
Seth Hastings & Son............	112,590	14,132	Print cloths............yds..	743,709	33,467
BROWNVILLE.					
Ontario Cotton Mills...........	295,000	35,400	Sheeting and shirting..yds..	875,000	64,000
CLARK'S MILLS.					
A. B. Clark & Co	482,668	62,747	Batting ....lbs..	116,251	13,369
			Rope and cord.........lbs..	113,317	15,864
			Sheeting and shirting..yds..	1,170,790	106,590
GILBOA.					
Morss Reed's Mills..............	144,000	20,160	Batting ....lbs..	750	75
			Sheeting and shirting..yds..	380,160	30,412
HAGAMAN'S MILLS.					
Pawling & Son	30,000	4,800	Under garments.......No..	54,000	31,500
MORRIS.					
Butternut Woolen and Cotton Factory Co	195,000	34,125	Sheeting ....yds..	689,000	51,675
NEWBURGH.					
Newburgh Steam Mills..........	851,541	108,769	Print cloths...........yds..	4,810,424	223,000
PITTSFIELD.					
Arkwright Co....................	135,700	18,658	Batting ....lbs..	5,730	515
			Print cloths...........yds..	652,000	32,600
RED FALLS.					
Red Falls Mill	242,746	32,164	Batting ....lbs..	4,438	444
			Sheeting and shirting..yds..	522,175	37,885
			Thread.......... ...lbs..	133	60
			Warp..................lbs..	23,354	4,204
			Yarn ....lbs..	28,931	5,182
			Knitting cotton........lbs..	287	86
			Wicking .... lbs..	1,645	312
			Twine.................lbs..	810	184

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	COTTON CONSUMED.		GOODS MANUFACTURED.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
NEW YORK—Continued.					
ROCHESTER.					
Jones' Cotton Mill	lbs. 430,000	$64,500	Quilt and skirt cotton .yds..	20,000	$2,000
			Prints.yds..	2,500,000	125,000
STITTVILLE.					
J. N. Draper	60,000	7,500	Warp.lbs..	400,000	16,000
TOODSVILLE.					
The Union Cotton Manufactory	147,600	19,188	Batting.lbs..	7,800	936
			Sheeting.yds..	416,000	29,120
			Yarn.lbs..	1,200	300
			Candlewick.lbs..	7,800	1,950
TROY.					
Troy Hosiery Co	14,000	90,000	....	....	....
Ida Cotton Mills	200,000	27,000	Sheeting and shirting..yds..	570,000	71,250
UTICA.					
Utica Steam Cotton Mills	1,350,000	175,000	Sheeting and shirting..yds..	3,000,000	....
NORTH CAROLINA.					
FAYETTEVILLE.					
Blount's Creek Manufacturing Co.	141,825	17,614	Batting, waste.lbs..	500	40
			Linseys.yds..	1,200	300
			Osnaburgs.yds..	19,701	2,167
			Sheeting and shirting..yds..	146,910	12,487
			Warp.lbs..	62,720	12,544
LEAKSVILLE.					
Leaksville Factory	350,000	45,500	Osnaburgs.yds..	120,000	14,000
			Sheeting and shirting..yds..	150,000	15,000
			Yarn.lbs..	240	....
NEW SALEM.					
Union Manufacturing Co	97,500	12,675	Drills.yds..	1,664	166
			Mattrasses.lbs..	150	7
			Sheeting.yds..	162,560	15,443
			Warp.lbs..	53,400	11,214
ROCKY MOUNT.					
Rocky Mount Mills	358,428	39,427	Yarn, twine, and rope .lbs..	323,125	58,162
SALEM.					
Fr. & H. Fries	150,000	17,250	Jeans.yds..	30,000	15,000
			Negro livery.yds..	85,000	22,000
			Warp and yarn.lbs..	105,000	23,100
PENNSYLVANIA.					
PHILADELPHIA.					
George Callaghan	492,700	73,905	Cassimeres.yds..	1,10500,	276,250

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	COTTON CONSUMED.		GOODS MANUFACTURED.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
PENNSYLVANIA—Continued.					
PITTSBURG.					
Eagle Cotton Works	lbs. 1,664,000	$216,320	Sheeting ....yds..	1,680,000	$134,400
			Yarn, twine, &c.......lbs..	675,300	140,000
Pennsylvania Cotton Mills	1,414,623	185,000	Batting ....lbs..	54,000	9,000
			Sheeting and shirting..yds..	2,686,900	255,255
			Yarn ....lbs..	233,156	50,000
			Waste ....lbs..	131,600	4,925
Hope Cotton Factory	1,600,000	200,000	Batting ....lbs..	84,700	11,858
			Yarn ....lbs..	1,202,500	264,550
			Candlewick..........lbs..	20,358	4,478
			Cotton, waste..........lbs..	137,560	3,439
RHODE ISLAND.					
ALBION.					
Albion Co	293,386	44,007	Prints..........yds..	1,643,489	90,392
BURRILLVILLE.					
Steere & Linkham	70,000	9,800	Satinets..........yds..	250,000	106,250
			Warp..........lbs..	32,000	9,600
CENTREVILLE.					
R. Lapham's Cotton Manufactory.	260,000	33,800	Sheeting and shirting..yds..	1,144,000	80,080
COVENTRY.					
Harris Manufacturing Co	495,905	66,120	Sheeting and shirting..yds..	1,844,600	151,027
HOPKINTON.					
Stillman & Berry	15,600	....	Linseys ....yds..	260,000	....
MILLVILLE.					
Wood, Star & Garrett	450,000	63,000	Sheeting and shirting..yds..	1,671,940	167,194
NEWPORT.					
Perry Mill Co	384,800	....	Print cloths..........yds..	2,000,000	115,000
NORTH SCITUATE.					
Isaac Saunders	210,000	30,150	Print cloths..........yds..	1,005,000	55,275
PROVIDENCE.					
Dyerville Manufacturing Co	500,000	75,000	Print cloths..........yds..	24,600	147,600
Meanville Mills	521,850	75,835	Sheeting and shirting..yds..	1,463,491	131,714
Hope Company	466,443	48,680	Sheeting and shirting..yds..	1,125,610	130,000
ROCKLAND.					
Rockland Factory	165,750	20,800	Print cloths..........yds..	936,000	45,250
VALLEY FALLS.					
Whipple Manufacturing Co	600	91	Thread........No. spools..	96,000	560
WARREN.					
Warren Manufacturing Co	565,500	90,480	Print cloths..........yds..	530,427	29,173
			Sheeting and shirting..yds..	1,623,353	146,102
WOONSOCKET.					
Clinton Manufacturing Co	650,000	84,500	Sheeting and shirting..yds..	2,600,000	210,000

Table showing the amount and valuation of cotton consumed in the United States, &c.—Continued.

	COTTON CONSUMED.		GOODS MANUFACTURED.		
	Quantity.	Valuation.	Class.	Quantity.	Valuation.
SOUTH CAROLINA.					
COLUMBIA.					
Columbia Mills	lbs. 640,000	$83,290	Osnaburgs ....yds..	1,000,000	$90,000
			Thread ....lbs..	100,000	17,000
EDGEFIELD.					
Graniteville Manufacturing Co...	1,482,000	194,290	Drills ....yds..	426,400	38,376
			Sheeting and shirting..yds..	3,900,000	331,500
TENNESSEE.					
OREGON.					
Oregon Mills	51,334	5,133	Warp ....lbs..	44,961	11,250
PARIS.					
Embryo Cotton Mills	191,332	17,220	Batting ....lbs..	7,565	832
			Thread ....lbs..	172,200	36,162
QUINCY.					
Quincy Cotton Mills	270,000	27,000	Osnaburgs............yds..	450,000	45,000
			Yarn .... .lbs..	45,000	9,000
VERMONT.					
FELCHVILLE.					
Merrill & Elgar	17,000	2,890	Cassimeres & doeskins.yds..	70,000	5,000
NORTH POWNAL.					
R. Carpenter & Co	25,000	4,000	Satinets ....yds..	500,000	250,000

CONSUMPTION OF COTTON IN EUROPE.

Letter of the Secretary of the Interior, communicating the report of John Claiborne, special agent appointed to collect statistics on the consumption of cotton in Europe.

DEPARTMENT OF THE INTERIOR,
March 19, 1858.

SIR: I have the honor to transmit herewith the report of John Claiborne, esq., the special agent appointed by the Commissioner of Patents to collect and report information upon the consumption of cotton in Europe.

Annexed to that portion of the report which relates to Bremen will be found a memoir upon the consumption of cotton in the Zollverein, for which the department is indebted to the courtesy of Doctor Schleiden, minister resident from the Free and Hanseatic Republic of Bremen.

With great respect, your obedient servant,

J. THOMPSON,
Secretary of the Interior.

Hon. JOHN C. BRECKINRIDGE,
President of the Senate.

UNITED STATES PATENT OFFICE,
March 19, 1858.

SIR: Agreeably to the clause in the act of Congress of March 3, 1857, for the collection of agricultural statistics, investigations for promoting agriculture and rural economy, and the procurement and distribution of cuttings and seeds, and to enable the Commissioner of Patents to collect and report information in relation to the consumption of cotton in the several countries of the world, I have the honor herewith to transmit the report of John Claiborne, the agent appointed to collect the cotton statistics of Europe under the clause in said act.

Very respectfully, your obedient servant,

J. HOLT, *Commissioner.*

Hon. JACOB THOMPSON,
Secretary of the Interior.

DEPARTMENT OF THE INTERIOR,
May 11, 1857.

SIR: A recent appropriation having been made by Congress "to enable the Commissioner of Patents to collect and report information in relation to the consumption of cotton in the several countries of the world," you have been selected to aid in carrying out the objects of that appropriation.

To render the desired information more reliable and complete, it has been judged expedient that you should visit different portions of Europe; and, as it is important that the result of your investigations should be laid before Congress at an early day of its next session, it will be necessary that you should commence your labors with the least possible delay.

Time will not permit you to visit all the countries in the world where cotton is consumed, nor would such a course be expedient if it were practicable. You will probably be able to extend your personal observations to the most important points in England, France, Russia, Switzerland, Austria, Prussia, and perhaps some of the other countries of Europe. You will here find sources of information extending to all quarters of the globe, and which will be sufficient to satisfy the present expectations of Congress.

Though the *consumption* of cotton abroad is the great subject of inquiry, your attention should not be limited too narrowly to that one point. It is evidently the intention of Congress to ascertain all facts which have a bearing, either directly or indirectly, upon that matter. The ultimate design is to benefit the cotton-producing and cotton-manufacturing interest of the United States.

Whatever will tend to this end is a subject of practical importance, and is recommended to your earnest and careful attention.

The traffic in this commodity, its manufacture, and even its production in foreign countries have a bearing upon its consumption, either present or prospective, and all facts relating to any of these matters will be within the proper scope of your inquiries.

Perhaps the clearest and most intelligible course of investigation will be suggested by an attempt to trace a bale of cotton from the time it leaves the plantation of the producer till it reaches the hands of the ultimate consumer. Every mile by which this route can be shortened, every obstacle which can be removed or avoided, every cent of expense which can be saved are advantages the benefits of which will be shared between the two individuals who stand at the extremes of this line of transit, and will cause not only an augmentation in the price of the raw material, but will create a larger consumption, and thus call for a larger supply of the commodity.

This, and subjects naturally connected therewith, will suggest all material inquiries which will be necessary in order to satisfy the objects of the appropriation.

In carrying out the general design thus intimated, your own judgment and sagacity will be chiefly relied upon.

It is impossible to mark out with precision, beforehand, all the details of an investigation where the ascertainment of one fact will often suggest others and render them material, where unexpected items of information will frequently present themselves, and where those which were anticipated will often be found to be beyond reach. It is thought proper, however, to specify, with greater particularity, some points and suggestions which have been already referred to in a more general manner.

The following points are, therefore, presented, as proper guides

for your attention and inquiry, and as embracing chiefly, if not entirely, the grounds you are expected to examine :

1. Ascertain the amount of cotton consumed in the manufactories of each city, district, or country, either in Europe, or any other portion of the earth where cotton is manufactured ; the amount of capital invested in such manufacturing establishments ; the number of looms and spindles ; the number of hands employed, and the average rate of wages paid to the employés. Aggregate results for each country or district are desirable, as far as practicable.

2. The immediate sources from whence these establishments actually procure their raw material ; the nearest seaport where they might be furnished direct from the United States, and the diminution of cost which might be effected by any change in the course of trade.

3. If direct trade were established, what are the commodities we should receive in exchange. Would this be sufficient in amount to furnish adequate return freights for the vessels employed in the transportation of cotton.

4. What proportion of the supplies furnished to these establishments is in the shape of yarn, and what in the shape of raw cotton. Ascertain the price of each, in order to show what profit is made by the manufacturer of the yarn.

5. What is the quality, grade, or number of the yarn principally used, and is it such as could be produced by the unskilled labor on plantations, or in the Southern cities.

6. To what countries do the manufacturers of Europe generally send their yarns and goods. and what diminution of expense would result from manufacturing or spinning in our own country, and shipping direct to those countries.

7. What duties are levied on cotton or yarn, respectively ; their effect on the consumption of each ; the feasibility of procuring their remission or modification, and the probable effect on consumption of such remission.

8. What are the agencies in each country which are now tending either to advance or check the consumption of cotton.

9. What new modes of applying cotton to the use of man are now in use in Europe ; to what extent is it used for mixing with wool in making cloths, cordage, or for any other purpose.

10. What proportion of the cotton goods consumed in each country is imported, and what supplied at home.

11. Examine the subject in its financial aspect ; inquire how, in the actual operations of commerce, a merchant could have his orders for cotton executed, and pay therefor at the ports of exportation. Examine also into the nature and course of exchange operations that would thus arise, and the practicability of avoiding the necessity of English or French banking credits.

12. Direct some attention to the subject of the production of cotton in foreign countries, with a view of ascertaining whether our planters may apprehend any formidable competition from any such source ; what are the obstacles in the way of such foreign production, and are they such as are likely to be removed hereafter.

It is not intended in the suggestion of the foregoing points to limit you rigidly by them. They are intended to aid, and not restrain investigation. Any other matters which may suggest themselves to your mind, calculated to promote the general object in view, should be made the subjects of inquiry. Nor is it supposed that upon each and all of the heads above enumerated full and explicit information can be obtained. Where this is found impracticable, or very inconvenient, time should not be wasted in fruitless searches.

You will keep this Department constantly informed of your movements, and by what channel of communication you are to be addressed, in case further directions or suggestions be thought expedient.

J. THOMPSON,
Secretary of Interior.

JOHN CLAIBORNE, Esq.

REPORT.

WASHINGTON CITY, *January* 22, 1858.

SIR: Congress having, at its last session, made an appropriation for the collection, under the direction of your bureau, of statistical information as to the consumption of cotton in the various countries of the world, the undersigned received from the Honorable the Secretary of the Interior the appointment as agent to carry out the intention of the legislative department.

It was soon recognized that the amount of the appropriation was wholly inadequate to the investigation of the subject, in the manner and to the extent warranted by its importance, in either the agricultural or commercial point of view; and, under these circumstances, I was directed to proceed, without unnecessary delay, to France and other continental countries of Europe, and, with all practical despatch, collect as much information as it might be in my power to do previous to the re-assembling of Congress.

On my arrival at Paris, about the beginning of June last, I called upon the Hon. John Y. Mason, the minister of the United States to the French empire, and made known the object of my visit. He received me most cordially, and throughout my stay in Europe manifested the warmest desire to forward the object of the investigation by procuring for me facilities, not only in France, but elsewhere. M. Alexandre Vattemare, agent of the Patent Office at Paris, also cheerfully aided me, and was the means of procuring for me much valuable information, not only at the capital, but in the manufacturing districts of Mulhouse.

Below will be found the results of the investigation, so far as it has been carried on, under the head of the countries visited. On no point is the information obtained so full and detailed as it might have been made under more favorable circumstances, or as it should be for the proper understanding of the subject, while, on some points of the

instructions, it has been wholly impracticable, from want of time, to procure any reliable information.

This cause prevented an examination into the amount of consumption and the condition of cotton manufacture in Holland, Bavaria, Wirtemberg, and Spain, which last country has, during the past few years, required a largely increased supply of our cotton for the spinning mills of Catalonia.

FRANCE.

France ranks next after Great Britain in the quantity and value of the cotton consumed, while the variety of articles into which it is fabricated is much greater. In the taste and beauty of her tissues she justly claims the first place among modern nations. Her mills send forth every description of cotton goods—from the common calicoes of Rouen to the richly figured muslins of Mulhouse, the gossamer tulles of Saint Quentin, and the exquisite tarlatanes of Tarare.

Scarcely sixty years have passed away since the first attempts at cotton-spinning were made at Paris, at a period, too, when the first French revolution was about to shake the country to its centre, to overthrow the old political system, to convulse society, and to affect, for a time, at least, most injuriously all the material interests connected with it. The progress of this new industry was, therefore, but slow for a considerable number of years after it was first planted.

From Paris, cotton-spinning spread rather gradually towards the departments of the North and East. According to Moreau de Jonnès, (*Statistics of the Industry of France; Paris*, 1856,) the first mule jenny used in France was imported from England into Ghent, (recently acquired by the French arms,) by the Brothers Bauwen, and presented to the first consul.

The first cotton-spinning in the department of the East, of which Mulhouse is now the central point, and which embraces portions of ancient Lorraine and Alsace, was in the establishment of Wesserling, in the year 1803, and specimens of yarn spun, either by hand or by the mule jenny, were exhibited at the *Exposition* of 1856; from which date it was recognized as "one of the established 'industries' of the country, and the fabrication of cotton rapidly became one of the leading interests, rivalling in its importance and value, in the commercial movements, that of the Cereals."

In 1816, the kilogramme of raw cotton was, as stated by Moreau de Jonnès, worth 6 francs, or about $1 12; and in 1851, it had diminished to 1 franc and 50 centimes, or about 28 cents, "and four times the quantity of cotton fabrics can be had for the same sum of money, while the proportion of 5 kilogrammes, or 11 pounds of cotton to every five inhabitants, had increased to 2 kilogrammes, or $4\frac{2}{5}$ pounds to each inhabitant; or, in its manufactured state, was sufficient to have furnished every inhabitant of the country with 18 metres, or about 20 yards of ordinary calico."

With respect to its cotton manufactures, France may be considered as divided into three great groups, or districts, although there are

many spinneries, weaving, bleaching or other establishments, not within the limits of either. These groups, or "circles," as they are generally called by the French manufacturers, or merchants, are: Normandy, of which Rouen is the centre; the East, with Mulhouse; and the Northeast, with its cities of Saint Quentin, Roubaix, and Lille. Each of these circles has its reputation for the production of particular descriptions of fabrics or tissues; thus Rouen is famed for the coarser styles and low prices, and is called the workshop of the poor; Mulhouse is famed for its Indiennes and its printed muslins, unrivalled, it is said, for beauty and richness of texture and coloring, and the taste displayed in their designs, by those of any other fabrication; Saint Quentin sends out the finest descriptions of tulles, organdies, &c.; while Lille and Valenciennes are the seats of the lace manufactories.

Tarare, near Lyons, has of late years sent into the Parisian markets the most beautiful and costly tarlatanes and embroideries, in the latter respect rivalling the renowned fabrics of St. Gall and Appenzell, in Switzerland; and Calais is following fast in the footsteps of Nottingham, in the production of bobbinets, and that description of laces for which the latter city has so long enjoyed a high degree of celebrity.

It was not in my power to obtain precise details of the establishment and progress of cotton manufacture in any of the above-named circles save that of the East; and these are owing to the courtesy of M. Emile Dolfus, president of the Industrial Society of Mulhouse, who furnished me with a copy of his very valuable and interesting notes, read before that body in the months of November and December, 1856, and which show, on every page, that they are the result of the most careful and conscientious study and examination into the subject.

After cotton-spinning was introduced in 1803, it remained nearly stationary until 1809–'10, when it began to increase in importance, and water power was first substituted for hand labor; the use of steam not being known until 1812, in the mill of MM. Dolfus, Meig & Co. The next five years brought with them wars, invasions, and political changes and excitements, which affected injuriously all kinds of industry. Between 1818 and 1825, prosperity had returned, and new and numerous establishments had been erected and put in operation; commercial derangements in 1828, and the revolution in 1830, had in turn their disastrous influence, which was again felt by the money crisis of 1837, and 1842–'43. Since 1851, the march has been rapid, and the business has met with its fair share of success and profit until the crisis of the present year, 1857, came on, under which it will have to share the suffering undergone by all manufacturing interests throughout Europe and America; a suffering which will, in all probability, be but temporary, to be succeeded by a long course of prosperity for them all.

Cotton-weaving began in this circle, at Mulhouse, in 1746, the first articles manufactured being Indiennes, the thread used being spun by hand, those spun by machinery not coming into use until more

than half a century afterwards, in the year 1800; and the flying shuttle being first employed in 1805. Shortly after this latter period, the importation of cotton tissues into France was prohibited; a policy which has been maintained to the present day amid all changes of government, and even to a modification of which the mill owners, with the rarest exceptions, manifest a stubborn spirit of opposition.

Weaving made as much progress, undergoing the same occasional and temporary reverses, as spinning and other branches of cotton manufacture. It extended gradually from the department of Haut Rhin into the other five which composed the circle, the mill owners generally adopting with readiness all new inventions in that branch, and the old system of hand looms disappeared before power looms, worked by water or steam, until in 1856. Of the total number of looms in the district, 42,329, there were 33,472 power, and only 10,859 hand.

Cotton-printing was established in Alsace, at Mulhouse, at the same time as weaving, and shortly attained to that reputation for the quality of its products which it has ever since enjoyed.

In connexion with many of the printing establishments are those for bleaching and dressing goods. The extensive establishment of Dolfus, Meig & Co., at Mulhouse, combines all the processes which the raw material undergoes from the time it reaches the mill doors until it is despatched to market; and within its walls, one may witness spinning, weaving, plain and figured, bleaching, (by a process considered by many superior to any elsewhere to be found,) dyeing and printing, (both by block and cylinders,) dressing and packing for market. Its chief is M. Jean Dolfus, who not only received your agent with much politeness, but manifested great interest in the subjects of his inquiry, and a disposition to afford him all possible information in its various branches.

According to M. Emile Dolfus, in the publication above alluded to, there are now in the circle of the East, which comprises the departments of Haut Rhin, Bas Rhin, La Haute Saône, Doubs, Les Vosges, and La Meurthe, 109 spinneries worked, 74 by steam and 97 by water, with an aggregate horse power of 8,199. These establishments have a total of 1,498,440 spindles for ordinary yarns, and 16,886 for twist, which makes the proportion of 183 to each unit of horse power; or if, as M. Dolfus remarks, it is considered that many of the steam engines are only auxiliary to water, which is subject to changes in its force and volume, the proportion will be really somewhat less.

The general proportion of spindles for ordinary numbers of yarns, 27-29 for warp, and 36-38 for woof, is from 180 to 200 for each unit of horse power.

The spindles were used as follows:

For waste and numbers under 20	75,000
Ordinary numbers 24 to 40, warp or woof	1,000,000
Numbers between 40 and 70	75,000
Fine numbers from 70 to 200	350,000

The production of yarns was 44,000,000 pounds, equal in value to $13,020,000, or $37\frac{1}{15}$ cents the pound.

The number of workmen employed by these establishments was 29,995; the wages paid, as I was informed by a mill owner, an average of 3 francs for men; for women 2 francs; and for boys and girls from 20 centimes to 1 franc per day.

M. Dolfus estimates the annual cost of spinning, per spindle, at an average of 35 francs ($6 51.) He also gives a table of the prices of raw cotton at Mulhouse since the year 1811, when it was 14 francs 85 centimes the kilogramme ($1 33 the pound,) to 1856, when it had fallen to the average of 2 francs 2 centimes the kilogramme (12 cents the pound,) for the classifications used in spinning ordinary yarns.

In 1811, the average price of the yarns at Mulhouse (27-29 warp and 36-38 woof) was 25 francs 61 centimes the kilogramme, (or about $2 33 the pound,) from which it had fallen, in 1856, to 3 francs the kilogramme, or 23 cents the pound.

The number of weaving mills in the circle, in 1856, is placed at 136, employing 37,897 hands, of whom 25,104 are engaged on power, and the remainder on hand looms. The production of cloths had increased from 2,000,000 pieces of 130,000,000 of metres (140,833,333 yards) to 2,500,000 pieces, of a total of 250,000,000 metres (270,833,333 yards.)

It had almost doubled during the last decade, and its value was set down at 100,000,000 francs ($18,600,000); the average price for ordinary calicoes in the Mulhouse market, which in 1835 was 77½ centimes, or near 14 cents the metre, had fallen to 39 centimes, or near 8 cents.

There were 25 printing mills, employing 10,400 hands, printing 51,900,000 metres of stuffs (56,225,000 yards) of the value of 51,500,000 francs ($9,579,000.)

M. Dolfus thus sums up the condition of the cotton manufacture in the circle in 1856, as regards capital invested and the ordinary expenses of working, &c., francs being reduced into American dollars. The entire number of hands employed being 78,812, and the motive power that of 14,323 horses:

Spinning, at a mean average of $6 51 per spindle, for 1,513,306 spindles, say	$9,750,746
Weaving, by mechanism, at $139 50 the loom, of which there were 33,472	4,670,340
Weaving, by hand, at $22 32 each, for 10,875 looms, buildings and machinery included	231,800
Printing	2,418,000
Bleaching and dressing	372,000
Total	17,442,886

These establishments had cost at least $29,760,000; the wages

yearly paid to their hands amounted to $6,596,000; and the annual value of all their different productions amounted to $41,478,000.

By far the greater portion of cotton consumed in the circle of Mulhouse is of American growth, and "middling" to "middling fair" qualities; there is some Sea Island and Egyptian also used; but Brazilian, East Indian, or other growths are but little known. Nearly the whole of the raw material goes *via* Havre, and thence by railway. Fuel is scarce and dear, the coal which is used being brought from Burgundy, along the canal which connects the Rhone and the Rhine, or from Coblenz, on the latter stream. Under the most favorable circumstances, it is said to cost three times as much as in England. Labor, however, is abundant; and while they admit that they can never rival England in ordinary and cheap cotton fabrics, and must depend upon the superior quality, taste and elegance of their fabrics, for a profitable market, the Mulhouse mill owners are, as a general thing, well pleased with their business and the profits which it affords.

It is to be regretted that there has not as yet appeared in the circle of Rouen any one who, like M. Dolfus, at Mulhouse, is the historian and statistician of its great manufacturing interests, as it is certainly well worthy, in extent and importance of the effort.

In his very interesting and instructive volume, *L'Industrie contemporaine, ses caractères et ses progrès chez les differents peuples du monde*, Paris, 1856—(Contemporaneous industry, its characteristics and progress among the different people of the world)—M. Audiganne says of the Normand Group, that if the number of spindles and the amount of raw material which they require be considered, it is the first in France; as out of the 70,000,000 to 72,000,000 kilogrammes which France consumes, they absorb about 30,000,000; and of the 5,000,000 spindles, which he estimates as the actual total in the country, it has between 1,500,000 and 2,000,000, though, as regards the value of its products, it does not preserve this relative position. While its fabrics are almost exclusively of the heavier and coarser qualities, at low prices, Rouen also manufactures for Algeria a species of very superior bleached cloth, which is in great respect for *burnouses*, &c., among the Arab population. It has also given the trade name of *Rouennaises* to those fabrics of its mills which are composed of yarn, dyed before it is woven, the hues of which are often mingled in odd and striking contrasts.

The circle of Rouen is composed of the departments of La Seine Inférieure, L'Eure, and Orne.

To the vice president and secretary of the chamber of commerce of the city I am under great obligations for their kindness, and the facilities for obtaining information which they afforded me.

The consumption for the year 1857, of this circle, was estimated at 140,000 bales, of 220 kilogrammes each, (67,000,000 pounds,) of which 15,000 bales, of not over 300 pounds, or the total weight of 4,500,000 pounds of Surats, &c., was included.

Very little Algerian or Egyptian is consumed, and that of other growths does not seem to be known, or at least asked for, in the market.

Rouen is one of the two points on the continent at which there was, to my mind, any evidence of an increase in the consumption of East Indian cotton, and its use for spinning unmixed with the longer stapled and finer qualities of the United States or other crops. The other point was at Ghent; and at both, the reason assigned was, the very high price of American cotton, which compelled the spinners to look for other supplies.

The qualities of American (United States) cottons principally in demand at Rouen are "middlings" and "good middlings;" the waste upon which, for "middling," is 4 to 5 per cent.; on "ordinary," 6 to 7; and in "low ordinary," from 7 to 11 per cent. Of the East Indian cottons, from Bombay, the waste is generally 20 per cent. greater than that of the corresponding classifications of American; the Madras cottons are, however, of better quality than those from Bombay.

In this circle, the yarns spun range in numbers between 4 and 36, the bulk of them being, according to a leading spinner, No. 26; the average price for that quality is 3 francs 60 centimes the kilogramme, or about 22 cents the pound.

It is claimed for the French yarn that it is 10 per cent. superior to that spun in England. The chief export of yarn from Rouen is of No. 20, for warps, which goes to Germany. The wages paid average 3 francs per day for men, and 1½ francs for women and girls. The proportion of the hands employed is two females to one male, and the length of the working day, as at Mulhouse, is 12 hours.

The following tables are derived from a publication of the Rouen Chamber of Commerce, entitled "Statistics of the Maritime Commerce and the Exportations of Tissues of Cotton and of Wool from the port of Rouen during the year 1855. Rouen: 1856:"

Comparative table of the tissues of cotton despatched from the custom at Rouen, either by sea or land, during the years 1853, 1854, *and* 1855. *Kilogrammes reduced to pounds.*

Description of tissues.	Quantities exported to the colonies in—		
	1853.	1854.	1855.
	Pounds.	*Pounds.*	*Pounds.*
Rouenneries	855,496	718,947	943,182
Indiennes	788,452	704,846	776,987
Handkerchiefs	5,584	12,648	86,277
Calicoes	5,912,275	5,864,773	7,288,877
Total	7,561,807	7,301,214	9,995,323

In the above are not included the cotton yarns exported, which amounted, in 1853, to 82,244 pounds; in 1854, to 69,980 pounds; in 1855 to 69,705 pounds.

Quantities exported to foreign countries.

DESCRIPTION OF TISSUES.	1853.	1854.	1855.
	Pounds.	*Pounds.*	*Pounds.*
Rouenneries	226,666	259,510	357,577
Indiennes	334,290	234,087	283,050
Handkerchiefs	16,969	12,597	58,014
Calicoes	23,235	11,589	74,098
Total	601,160	517,783	772,739

Totals for colonies and foreign countries.

DESCRIPTION OF TISSUES.	1853.	1854.	1855.
	Pounds.	*Pounds.*	*Pounds.*
Rouenneries	1,782,142	978,457	1,300,759
Indiennes	1,122,741	939,013	1,060,037
Handkerchiefs	22,552	22,245	144,291
Calicoes	5,937,509	5,876,363	7,362,978
Total	8,864,944	7,816,078	9,868,065

Of these exportations, there came to the United States, in the year 1853, 55,748 pounds ; in 1854, 47,828 pounds ; and in 1855, 69,179 pounds ; the values not being given.

The mills in Brittany, like those of Normandy, supply only the lower numbers of yarns and cheap stuffs ; those of French Flanders, on the contrary, turn out the finest and most costly description of tulles, blondes, and gauzes, and it is there that is consumed almost the entire importation of our Sea-Island cottons. It has not been long since the artisans of Tarare began to send into market those exquisitely fine and beautiful fabrics of cotton which have won the admiration of all who behold them. In cotton embroideries, Tarare produces articles "quite equal to the best Swiss in fineness, suppleness, and finish, and superior to them in the chasteness and beauty of their patterns." The perfection of the skill and taste they display in the finer and more costly styles of cotton stuffs may be appreciated from the fact, as stated by M. Audiganne, that when the society of church-wardens of Nancy desired to present an embroidered robe to the Empress Eugenie, they procured it to be made at Tarare, the threads being number 480, and the amount of raw cotton used for it being half a kilogramme, or one and one-tenth pounds. If, says M. Audiganne, the thread used for this robe, and coming from so small an amount of material, had been extended in a line, it would have reached 480 kilometres, or 120 leagues. This distance is nearly equal to 291 miles.

But by far the greater portion of the yarn spun and woven in France is of the numbers running from 12 to 80, the use of any above the latter being considered as exceptional ; as a matter of economy in their operations, the mill owners regard the spinning of 50 kilogrammes of cotton into the finer numbers, as requiring as much labor as to turn from 700 to 800 kilogrammes into the lower ones. Up to the year 1834, the importation of yarns was prohibited ; and since that date, the relaxation of the policy only operates in favor of those above No. 143, the duty upon which is regulated by weight.

Of late years, the production of yarns in France has not only sufficed for home consumption, but has also been exported in considerable quantities to other countries.

M. Moreau de Jonnès, in his late very valuable work, "*La Statisque de l'Industrie de la France*," (Statistics of French Industry,) has a chapter on cotton, which abounds in interesting facts and speculations. After giving a rapid sketch of the rise and progress of the manufacture in France, the author proceeds to show its influence upon the industrial and commercial wealth of the country as it at present exists. According to this high authority, the value of the production of cotton tissues and its relation to the population, was, in the year 1812, 176,000,000 francs, ($32,736,000,) being 6 francs ($1 12) to each inhabitant; while in 1850, it was 334,000,000 francs, ($62,124,000,) being 10 francs to each inhabitant. By the census of 1851, the population of France was 35,783,170. Says M. de Jonnès, p. 76, "The 62,000,000 (kilogrammes) imported for the spinneries, being transformed into tissues and other fabrics, worth at least 334,000,000 francs, the industry of our manufactures quintuples the value of the raw material, and augments it four times ; or, in other words, gives it an increased value of 250,000,000 francs." Estimating the total consumption by Great Britain, Continental Europe, and the United States, at the time he was writing, (probably 1855,) at the round sum of 502,000,000 kilogrammes, (1,104,400,000 pounds,) he says : "At 1 franc 50 centimes (the kilogramme) here is a value of 753,000,000 ($140,058,000.) If the raw material should be everywhere quintupled, as in France, the annual industrial production of cotton would be near 4,000,000."

"Certainly, when Columbus remarked at the Lucayas a bush with mallow flowers, the seeds of which were enveloped in a silky down, he did not anticipate that *there* was a treasure far more precious than the gold mines of Cibao, and that it would have been better for him to have put the Indians to planting cotton than to digging into the auriferous hills of Hayti, which were to become their tombs."

M. de Jonnès gives tabular statements as to each branch of cotton manufacture in France, which are embodied herein as well worthy your attention. For convenience sake, the French weights and values have been reduced to our own standards. His estimate of the number of spindles is considerably below that of several other authorities—M. Audiganne placing the number at 5.000 000.

COTTON SPINNING.

Number of mills	566
Communes in which they are found	275
Their consumption of raw material, (pounds,)	138,226,000
Value of the same, (dollars,)	17,519,756
Quantity of cotton spun, waste not included, (pounds,)	127,600,000
Total value of the yarn spun, (dollars,)	27,379,200
Number of hands employed, (of whom, 22,807 men, at 37 cents; 23,531 women, at 19 cents; and 16,726 children, at 10 cents per day,)	63,064

Raw material, 65 per cent.
Salaries, general expenses, and profits, 35 per cent.

NOTE.—The rate of wages given here is at least one-third below those which, I was informed by proprietors, were paid at Mulhouse and Rouen. They had probably risen meanwhile.

Summary of the value of the general production of cotton tissues.

COTTON TISSUES.	Number of establishments.	Value of raw material (cotton yarn.)	Value of productions.
Cotton, pure	1,484	$18,385,082	$30,448,200
Cotton, open work	46	1,004,400	2,697,000
Cotton, mixed	195	6,942,450	10,387,914
	1,725	26,321,932	43,533,114
Subordinate articles	11	288,114	395,623
Total	1,736	26,610,046	43,928,737
Accessories to unmixed tissues	287	10,977,714	15,427,148
Accessories to mixed	17	807,612	1,755,282
Total	304	11,785,326	17,182,430
General total	2,040	38,395,372	61,111,167
Number of spinneries	566		
	2,606		

Number of workmen and machines.

COTTON TISSUES.	Hands.	Looms.
Cotton, pure	145,474	92,623
Cotton, open work	17,377	1,687
Cotton, mixed	25,716	16,693
Total	188,567	111,003
Subordinate and accessory articles	23,299	2,370
Total	211,866	113,373
Add for spinneries	63,064	16,301
Making altogether	274,930	129,673

NOTE.—"The figures," says M. de Jonnès, "were obtained by official inquiries at each establishment, being the only ones yet collected on this important subject. Two thousand and forty establishments," continues the author, "consume raw material valued at $38,395,372 ; their operations, by the aid of 212,000 workmen and 113,000 machines, increase this value to $61,111,167, or by one-half; and it must not be forgotten that the raw material of the tissues, produced by this admirable and surprising industry, is cotton yarn, to work which costs twice as much as does raw cotton."

If, to find the total value obtained by the labor of our 2,000 establishments, raw cotton were taken as the basis of the calculation, the increased value would be found much more considerable. The quantity of 138,226,000 pounds, destined for spinning mills, is worth only $17,519,756, from which are fabricated tissues worth $62,012,400—an increase in value equal to 350 per cent.

Cotton is used in France mixed with wool, flax, or silk in greater or less proportions. It enters into the fabrication of velvets, silk cravats, or vestings, rich moire-antique stuffs, satinets, broadcloths, and linens ; and it would seem that the progress of art and the necessity for new materials are destined to add still further to its already multifarious uses. Want of time for that object rendered it impracticable for me to examine particularly into this branch of cotton consumption, either in France or any other country which I visited. It is well worth an extended and careful examination.

According to M. de Jonnès, 212 establishments, employing 26,000 hands, and with the latest and best descriptions of machinery, are engaged in the fabrication of articles of which cotton, mixed with silk, wool, or flax, is a component part. The mills are one-tenth the number of those devoted to weaving pure cotton, and the number of hands is one-ninth of those so engaged.

The work of M. de Jonnès gives the following summaries of the different branches of cotton manufacture in France, after the raw material has been converted into yarn or thread :

I. TISSUES OF PURE COTTON.

Number of establishments		1,484	
Value of the spun cotton used in them		$18,384,806	
Value of the tissues fabricated		30,448,200	
Total number of hands employed		145,474	
namely: Men	69,410		
Women	52,932		
Children	23,125		
Men, wages, 1 franc 50 centimes, (28 cents,)		$3,868,800	
Women, 85 centimes, (15 cents,)		2,247,922	
Children, 50 centimes, (9 cents,)		645,048	
Looms, 92,623; other machines		2,820	
Spindles		190,336	
Value of articles fabricated		30,448,200	
Value of cotton yarn and thread		18,384,896	= 60 per cent.
Profits, wages, and general expenses,		12,090,000	= 40 "
namely: Wages		6,755,148	= 22 "
Profits and general expenses		5,327,412	= 18 "

II. *Transparent and other tissues.*

NUMBER OF ESTABLISHMENTS.		Value of raw materials.	Value of products.	Number of hands
Tulles	19	$930,000	$2,087,292	10,777
Machines	1	8,556	111,600	60
		938,556	2,198,892	10,837
Laces	1	1.012	3,739	400
Embroideries	25	63,984	502,200	6,140
Total	46	1,003,552	2,704,821	17,377

III. *Accessories to the fabrication of tissues.*

Bleaching and dyeing	177	$4,110,600	$5,601,390	3,859
Printing calicoes, &c	87	5,712,060	8,616,054	10,081
Cambrics	23	1,469,400	2,306,400	3,888
Total	287	11,292,060	16,523,844	17,828

IV. *Subordinate articles.*

Wadding	1	$2,790	$6,510	18
Cords and twist	4	74,400	111,600	180
Candle wick	2	51,336	74,467	135
Fringes and suspenders	4	163,680	204,972	250
Total	11	292,206	397,549	583

V. *Mixed cotton tissues.*

NUMBER OF ESTABLISHMENTS.		Value of raw materials.	Value of products.	Number of hands.
Cotton and wool velvets and carpetings	42	$3,496,800	$4,964,800	7,043
Cotton and wool net-work, blankets, and furniture covers	16	1,302,000	1,805,198	6,690
Cotton, wool, and flax	5	156,498	279,000	685
Cotton and silk	62	669,300	967,200	1,617
Cotton, silk, and goats' wool	25	163,202	316,200	1,170
Cotton, wool, and silk	45	1,171,800	1,957,258	8,511
Total	195	6,959,600	10,289,656	25,716

Accessories to the same.

Cotton and wool-spinning and dyeing	15	$799,800	$1,729,800	4,748
Dressing	2	11,346	31,248	140
Total	17	811,146	1,761,048	4,888
General total	212	7,770,746	11,050,704	30,604

Looms	16,693
Other machines	7,802
Spindles	71,802

The pure cotton tissues of French fabrication are calicoes, Indiennes, percales, ginghams, madopolain, jaconet, organdie and figured muslins, printed muslins, handkerchiefs and shawls, tulles, bobbinets, laces, bonnetine, (caps, undershirts, drawers, gloves, &c.,) and fringes and nankins.

DUTIES.

The French government levies discriminating duties on cotton, taking into consideration not only the place of growth, but the mode of transport. A reference to the accompanying table, marked B, will show the amount of the duties levied on each description. The table marked A, and which is official, shows the amount of cotton imported into France from all countries during the periods therein named. It will be seen that the amount of duties paid for the year 1856 was $3,712,286, (19,851,000 francs,) upon a total receipt of 183,488,200 pounds. As to the quantity of cotton of the growth of the United States imported in that year, it will be seen that it paid more than 90 per cent. of the entire revenue from that source.

The *Tableau général du commerce de la France* for 1856 places the amount of duties received from cotton imported from the United States at 18,777,229 francs, and the proportion to the whole amount of duties levied on importations from that country, at 90½ per cent.

This document also places the total importation of American cotton for that year at 974,793 metrical quintals, (221 pounds,) equal to 215,469,033 pounds; of which 786,994 metrical quintals (173,926,744 pounds) were for consumption, and the balance of 41,543,259 pounds in transit.

The following table, showing the quantity of cotton imported into France for the first nine months of the year 1857, with the amount of duties received therefrom, and a comparison with the quantities imported and the duties received for the same periods in the years 1855–'56, is made up from an official publication in the *Moniteur Universel*, of October 19, 1857, the French weights and values being converted into corresponding American weights and values:

IMPORTATIONS.	1857.	1856.	1855.
	Pounds.	*Pounds.*	*Pounds.*
From the United States	159,125,083	175,613,672	154,459,331
From other countries	21,509,448	12,238,096	13,292,990
Total	180,634,521	187,851,768	167,752,521
Taken for consumption	121,928,593	140,180,963	135,696,652
Duties received	2,976,000	2,820,200	2,659,800
Stock on hand, September 30	40,807,871	36,691,726	22,322,768

Of which, in 1857—	*Pounds.*
At Marseilles	2,794,103
At Bordeaux	360,671
At Nantes	462,879
At Rouen	267,189
At Havre	36,174,385
At Dunkirk	181,662
At other ports	565,981
Total	40,807,871

The accompanying tables, marked, respectively, C, D, and E, all of which are from an official source, will exhibit—

1st. The quantities and values of the various descriptions of cotton stuffs, of French fabrication, exported during the years specified.

2d. The quantities of yarns and tissues, with their values, of French fabrication, exported.

3d. A list of countries, and the value of cotton tissues, of French fabrication, exported to each during the years specified.

With regard to the commercial exchanges between France and the United States, it will be seen, by reference to the official statements in the *Tableau général du Commerce* for 1856, that France took from us merchandise equal, in its real value, to $50,945,400, of which she

consumed to the amount of $41,440,800; while we imported from her merchandise of the real value of $95,508,000, of which $60,189,600 were articles of French growth or fabrication. Among them were silk tissues and other stuffs, to the value of $27,844,200; tissues, embroideries, and ribbons of wool, to the value of $5,811,756; tissues, embroideries, and ribbons of cotton, to the value of $874,200; wines, to the value of $6,106,000; brandies and spirits, to the value of $2,269,200; pottery, glass and crystal ware, to the value of $1,029,324; dressed skins, to the value of $2,213,400, &c.

The above details will show that the condition of cotton manufacture in France is highly prosperous and remunerative, and there is no reason why the consumption of cotton should not go on increasing. The comparative dearness of fuel for manufacturing purposes is more than counterbalanced by the abundance and cheapness of labor and the monopoly of the home market, with a demand for cotton tissues and stuffs for clothing or luxury, which is daily augmenting. Nevertheless, the cotton-manufacturing interest is at present in a nervous and excited state, owing to the exertions of the advocates of greater freedom of trade, and the abolition or radical modification of the prohibitory system.

While all the arguments of the friends of the existing policy are earnest, and often even impassioned, some of them are rather amusing. Rouen may be regarded as the very centre of the influence of the prohibitory policy, and it was there that I met with a small pamphlet, entitled *Le Libre Echange et le Droit d'Aînesse en Angleterre, par un Rouennais*, (free trade and the law of primogeniture in England, by a resident of Rouen,) in which the writer attributes England's great manufacturing prosperity mainly to the cheapness of coal and the law of primogeniture; warning his countrymen of the political and social evils which will inevitably follow, should France open her ports, in imitation of her neighbor, to foreign cotton manufactures.

That a modification—the greater the better—of our commercial treaty with France, would be followed by an increased consumption of our cotton and other products, and would tend to the increased prosperity of both countries, does not admit of reasonable doubt.

At Rouen, particularly, the high price of American cotton was complained of by the mill owners, and, as a consequence of it, I was told that, on an estimated consumption of 140,000 bales, in the circle, for the year 1857, at least 15,000 would be of East Indian growth. Some of the spinners there had begun to spin East Indian cotton, unmixed with the longer and better stapled American, as has heretofore been the case in France and elsewhere in Europe; the proportions being one-third or one-fourth East Indian to two-thirds or three-fourths American. In the circle of Mulhouse, at least five-sixths of the raw cotton consumed is of American growth.

A.

Table showing the quantity of cotton imported for consumption into France, together with the amount of duties paid on it, and the countries whence it came, for the two decennial terms, from 1827–1836 *and* 1837–1846, *and also for the years* 1854, 1855, *and* 1856.

[The original furnished by M. Fleury, director of external commerce in the ministry of agriculture, commerce, and public works of the French empire.]

To reduce the French kilogrammes into pounds, it has been assumed as equivalent to $2\frac{1}{5}$ of the latter; to reduce francs into dollars, 1 dollar is taken as equal to 5 francs and 33 centimes.

WHENCE IMPORTED.	1827–'36.	1837–'46.	1854.	1855.	1856.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
United States	59,785,000	108,708,600	148,376,600	158,085,200	173,137,800
Venezuela		255,200	121,000	239,800	165,000
Brazil	3,245,000	1,368,400	233,200	259,600	506,000
Peru	15,400	363,000	558,800	391,600	651,200
Hayti	213,400	180,400	125,400	123,200	123,200
Guadalupe	114,400	147,400	59,400	92,200	85,800
Algeria				28,600	48,400
English East Indies	499,400	770,000	158,400	525,800	693,000
Turkey	2,604,800	3,458,400	1,258,400	908,600	547,600
Egypt	5,827,800	3,555,200	5,101,800	5,977,400	6,778,200
Indirectly imported.					
England	72,200	37,400	276,200	677,600	2,222,000
Belgium	50,600	48,400	869,000	129,800	101,200
Other countries	1,190,200	1,148,400	248,600	41,800	248,600
Total	73,625,200	120,040,800	157,386,800	167,479,200	183,488,200
Value in dollars, (official,)	10,969,164	17,971,878	23,659,200	25,128,600	27,829,320
Duties paid in dollars	1,345,324	2,178,060	2,881,928	3,145,260	3,712,286

B.

Tariff of duties levied on cotton imported into France. Kilogrammes converted into pounds and francs and centimes into dollars and cents.

COTTON.	By French vessels, per 221 pounds	By foreign vessels, or by land.
From French colonies	Free	Free
Turkey	$2 79	$4 65
India	1 86	
Elsewhere, out of Europe	3 72	
Entrepôts	4 65	
By land		4 65
Unginned cotton from—		
French colonies	2	
Turkey	71	1 30
India	48	
Elsewhere, out of Europe	95	
Entrepôts	1 18	
By land		1 30
Wadding	18 60	20 00

NOTE.—In converting francs and centimes into dollars and cents, in the above table, it was found necessary, in some instances, to add to or throw off small fractions in order to make a full number.

C.

Statement of the various descriptions of cotton stuffs, of French fabrication, exported from France between the years 1844 *and* 1846, *and* 1854 *and* 1856, *(also furnished by M. Fleury, director of foreign commerce, of the ministry of agriculture, commerce, and public works of the French empire,) expressed in pounds.*

YEARS.	Muslins, percales, and calicoes.		Shawls and handk'chiefs.	Printaniers and nankinettes.	Gauze.	Other descriptions of fabrics.	Total fabrics.	Official value.*	Bounties paid.†
	Grey and bleached.	Colored and printed.							
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Dollars.*	*Dollars.*
1844	3,390,000	5,009,400	547,800	26,400	26,400	2.182,400	11,182,600	20,183,796	184,698
1845	6,129,200	4,600,200	770,000	44,000	26,400	2,411,200	13,981,000	23,775,264	248,682
1846	4,765,200	6,300,800	1,018,600	19,800	24,200	2,226,400	14,355,000	25,995,360	265,608
1854	7,994,800	5,865,200	723,800	2,200	52,800	2,208,800	16,847,600	‡28,757,460	320,478
1855	10,780,000	6,879,400	1,038,400	4,400	85,800	2,785,200	21,573,200	§36,456,000	411,990
1856	9,011,200	6,923,400	772,200	6,600	96,800	3,359,400	20,169,600	‖34,670,400	390,600

* The official value has been used since 1826.

† These bounties consist in the refunding by the government of the duties paid on the raw material.

‡ Real value, $11,184,924.

§ Real value, $13,782,600.

‖ Real value, $13,410,600.

D.

Table of the quantities and values of yarns or cotton tissues, of French manufacture, exported from France during the decennial periods of 1827—1836, *and* 1837—1846, *and also for the years* 1854, 1855, *and* 1856; *the original furnished by M. Fleury, director of foreign commerce.*

DECENNIAL AVERAGE.	QUANTITIES.			OFFICIAL VALUE.		REAL VALUE.	
	Yarns.	Tissues.	Total.	Yarns.	Tissues.	Total.	Yarns & tissues.
	Pounds.	*Pounds.*	*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*
1827—1836	237, 600	4, 695, 200	5, 332, 800	110, 112	10, 114, 680	10, 224, 792	....
1837—1846	*563, 200	9, 486, 400	10, 049, 400	534, 400	18, 174, 432	†18, 528, 576	....
Years—1854	504, 000	16, 847, 600	17, 353, 600	341, 682	28, 754, 460	29, 097, 282	11, 178, 600
1855	484, 000	21, 573, 200	22, 057, 200	307, 732	36, 456, 000	36, 773, 732	13, 905, 546
1856	569, 800	20, 169, 600	20, 739, 400	386, 136	34, 670, 400	35, 057, 536	14, 866, 980

* M. Fleury remarks that this average is so large on account of the extraordinary quantity of yarn exported during the last two years of the decade, it having been 1, 742, 400 pounds in 1845, and 2, 125, 200 pounds in 1846, of the respective values of $1, 177, 752 and $1, 437, 966.

† The real value of merchandise has only been adopted since the year 1847.

E.

A list of countries to which cotton tissues of French fabrication were exported, with the values of the same, from 1844 *to* 1846, *and from* 1854 *to* 1856, *(furnished by M. Fleury, director of foreign commerce in the ministry of agriculture, commerce, and public works of the French empire,) the values being official.*

COUNTRIES.	1844.	1845.	1846.	1854.	1855.	1856.
Algeria	$4,445,400	$8,351,400	$6,640,200	$10,323,200	$15,140,400	$12,424,800
Other French colonies	3,124,800	3,162,000	4,473,400	3,868,800	4,036,200	3,999,000
Spain	4,891,800	3,757,200	4,780,200	2,808,600	3,831,600	3,608,400
United States	1,078,800	1,339,200	1,822,800	1,246,200	1,469,400	1,897,200
England	334,800	427,800	762,600	1,848,400	1,598,200	1,729,800
Sardinian States	1,102,000	1,176,400	1,784,200	1,120,600	1,176,400	1,692,600
Switzerland	985,800	1,153,200	1,395,000	1,060,200	1,450,800	1,618,200
Belgium	632,400	818,400	688,200	1,320,600	1,413,600	1,432,200
The Zollverein	520,800	613,800	725,400	911,400	930,000	1,116,000
Brazil	213,200	279,000	297,600	837,000	818,400	892,800
Turkey and Greece	93,000	148,800	130,200	279,000	390,600	669,600
Mexico	539,400	316,200	409,200	390,600	372,000	539,400
Naples and Sicily	74,400	204,600	353,400	239,000	427,800	446,400
Hayti	651,000	502,200	483,600	427,800	558,000	353,400
Tuscany and Papal States	409,200	141,800	279,000	167,400	204,600	297,600
Chili	55,800	111,600	148,800	204,600	372,000	297,600
Foreign West Indies	167,400	260,400	297,600	372,000	316,200	279,000
Buenos Ayres and Uruguay	18,600	37,200	18,600	372,000	372,000	279,000
Columbia*	37,200	74,400	241,800	148,800	241,800	213,200
Africa	111,600	55,800	55,800	148,800	204,600	167,400
Peru	18,600	55,800	55,800	180,600	446,400	130,200
Other countries	465,000	483,600	539,400	141,800	465,000	576,600
Total	20,181,000	23,770,800	26,002,800	†28,755,600	‡36,456,000	§34,670,400

* Including New Granada, Ecuador, and Venezuela.

† The real value was $11,184,924.

‡ The real value was $13,782,600.

§ The real value was $13,410,600

SWITZERLAND.

Entirely surrounded by other nations, with political institutions of an exceptional character on the continent of Europe, and forced to depend on the comity or caprice of her neighbors with maritime frontiers for her supplies of the raw material, Switzerland yet occupies so important a place in the cotton manufacture of the day, and combines so many advantages as to the abundance of capital and labor, as to rank next after Great Britain and the United States in the cheapness of her productions in that branch of industry.

With her, increased cost of raw material and motive power may be said to be compensated by low wages and greater artistic skill in the handling of the various fabrics which are sent out from her mills. In the year 1850, her entire population was 2,392,740, and in 1852, the cotton imported for consumption was 245,422 quintals, of 50 kilogrammes, or 110 pounds each, making 26,996,420 pounds, or 11,028 pounds to the inhabitant; while her export of cotton yarn, twist, and fabrics of various kinds, summed up to 150,758 quintals, or 15,088,590 pounds, being an average of 6,028 pounds to the inhabitant; leaving an average consumption of more than 5 pounds to the inhabitant.

Previous to the period of my visit to Switzerland, the only published history of the origin, progress, and condition of the cotton manufacture of the country was that of Sir John Bowring, who visited Switzerland as the commissioner of the British Board of Trade, and whose "Report on the Commerce and Manufactures of Switzerland," addressed to that body, is to be found in volume 45 of the parliamentary papers, session of 1836.

In July last, "The Trade Statistics of Switzerland," by Mr. Emile Weber, was published at Zurich, and, being more than 20 years later in date than the report of Sir John Bowring, may well be supposed to contain more accurate information as to the actual condition of manufactures in the country. The courtesy of a correspondent of Berne enables me to refer, in a subsequent portion of this report, to Mr. Weber's account of the number of cotton mills in Switzerland.

Like all who visit the Swiss confederation, Sir John Bowring was most favorably impressed with those evidences of industry, comfort, and well-being which everywhere meet the eye of the stranger; and he pays, on more than one occasion, an eloquent tribute to the thrift, skill, intelligence, and hospitality of the people. Patient industry, regulated economy, immense capital, and a generous hospitality, would seem to be hereditary with these bold and independent mountaineers, whose hands are as cunning in the workshop as they are unflinching in the field of battle.

According to Mr. J. G. Zellwegger, of St. Gall, in a communication addressed to Sir John Bowring at the time of his visit, cotton manufactures were known at Zurich as early as 1419, and he cites a law of the canton of Lucerne, enacted in 1423, ordering that cotton should thenceforth be sold by weight. It may be that this was the origin of

the custom, still so generally prevalent in Continental Europe, of giving in trade returns, or tables of imports and exports, the quantities of cotton and other tissues imported or exported into any country, by weight instead of measure, in ells, yards, &c. The markets for the goods fabricated in the fifteenth century were France, Italy, and Germany. The fabrication of cotton cambrics (bazins) was commenced in Appenzell, about the year 1746, the period, it will be remembered, of the establishment at Mulhouse, then a portion of the Swiss territory, of manufactures of Indiennes. This, said Mr. Zellwegger, was a fortunate thing for the canton, as the war which broke out in the East Indies ten years afterwards, between England and France, brought manufactures of cottons and muslins into great demand, and several new establishments for bleaching and dyeing, with dressing machines and machinery for printing calicoes, were put into operation.

Cotton-spinning, by hand, of course, also began about the same period, "the spinner being able to earn 3 florins ($1 20) a week, and a weaver double that amount, while a measure of wheat of 25 pounds (20 ounces each) did not cost more than 40 kreutzers, or two-thirds of a florin." "It was about this period," continues Mr. Zellwegger, "that the firm of Gruzebach introduced the art of embroidering, which commenced by embroidering the wrists of men's shirts." A visit to St. Gall, last July, brought me the acquaintance of Mr. Zellwegger, of the very respectable house of Holderegger & Zellwegger, to whose obliging attentions and great intelligence I became greatly indebted, and was enabled to see many of those beautiful embroideries and figured muslins for which that city has become renowned, and which are the work of the peasantry in the neighboring mountains of Appenzell. The days of embroidered frills and powdered perukes have long since passed away, but of exquisite collars and sleeves to deck, though not conceal, the necks and arms of the belles of the present day, there was an almost endless variety.

The conclusion of the treaty of 1783, between England and France, brought with it a great reduction in the price, but not in the demand for Swiss manufactures, and a machine for making twist thread for embroideries was introduced, being the "first machine established in the canton." Attempts were also made to manufacture water twist and mule twist, as in England, and a native mechanic invented a machine to spin cotton, "which," observes Mr. Zellwegger, "was much inferior to the British machines."

The following paragraph will show how the Swiss manufacturers looked at opposition and its probable consequences at that period:

"Cotton manufactures were now established in France, and our workmen were bribed away in order to conduct them. This occasioned several prohibitory proclamations on the part of our magistrates, which were attended with as little effect as were the silly lamentations which in every direction predicted the utter ruin of our industry by the progress of manufactures in France. The French, on the other hand, raised a similar cry, should our goods be permitted to be placed in competition with the manufactures of that country.

But all these fears and prognostications were without foundation; our manufactures continued to increase."

And so, might he have added, did those of France and every other country engaged in the like industry. An increase which, vast as it has already proved, is, in all probability, destined to a further expansion, the limits of which few, at all acquainted with its history, will venture to prescribe.

The French government, carrying out that policy of prohibition which appears to have reigned in its councils since the days of Colbert, at this period prohibited the introduction of Swiss cotton goods, which was followed by a fall in their prices of from 40 to 50 per cent., a shock hard to bear, but not so disastrous as it might have otherwise proved, as it was followed by a system of smuggling on an extensive scale. In the year 1797, English machine-spun cottons first made their appearance in the Swiss markets; but the demand for them was checked by the general belief that they were inferior in strength and durability to yarns spun by hand. The spinners, meanwhile, took the occasion to improve themselves in weaving and embroidery, and their general prosperity continued until the French invasion, in 1798, and the occupation of the country by the victorious troops of the new republic, subsequent to which an almost complete stagnation was visible.

For some years, Switzerland continued to constitute a part of the French republic, or the empire which succeeded it, and shared its fortunes in commerce and manufactures; the latter of which, particularly after the treaty of Amiens, suffered no little from the increased facilities for cheap productions afforded in England by new inventions in various branches of the art. The spinners of St. Gall, however showed no antipathy to these new systems of labor, but availed themselves readily of whatever advantages they possessed; and in 1800, the year of its introduction, as has already been said, through Ghent into France, the English spinning machine was introduced into St. Gall, followed, in 1801, by power looms, machines for dressing cloth, and a chemical process for bleaching.

The wars of the French empire and the changes brought about by the events which accompanied them, together with the commercial policy proclaimed subsequent to the overthrow of that empire by most of the leading continental powers, had a marked, and in many respects, a very ruinous effect on the fortunes of the Swiss cotton manufacturers; and, deprived of their accustomed markets, they began to turn their eyes towards the United States and even remoter markets; the result has been an ample reward for their enterprise and skill.

At the time of Sir John Bowring's visit, in 1835, the canton of Zurich had not taken the position of superiority in Swiss cotton manufacture which it now unquestionably holds, as it possesses 503,369 of the 1,112,303 spindles and 2,595 of the 7,779 looms to be found in the country. As is said above, cotton manufactures had their origin there early in the fifteenth century, and exhibited a gradual increase until the beginning of the present century, when, in 1802, an Eng-

lishman introduced, though with defective machinery, the spinning of water and mule twist; but it was not until five years afterwards that machinery sufficiently perfect to insure prosperity to that branch was introduced.

The consumption of cotton, in 1835, was about 3,360,000 pounds, which was spun into yarns varying in Nos. from 20 to 40, although a mill at Winterthur sent out No. 120. The number of persons then employed in that canton, in spinning, was about 5,000; the average wages being, for men 3½, the women 2, and the children 1½ florins per week. (The florin was equal to 60 kreutzers, or 40 cents of our currency. It is not now used, having given place to francs and centimes, of the same value as those of France and Belgium.)

At the same period there were about 12,000 weavers and 4,000 other persons engaged in cotton manufactures; 800,000 pieces of cloth were manufactured yearly, with 19 printing establishments, employing 1,000 persons, and producing yearly about 100,000 pieces of calico. The canton had then 225,000 inhabitants. and in 1850, they had increased to 250,698.

The canton of Aargau, or Argovia, as it is also called, occupied, in 1835, the next rank to Zurich in cotton-spinning and weaving; at this day it has the same number of mills for spinning as St. Gall, though the number of spindles exceeds that of the latter canton. Aargau produces, principally, the lowest numbers of yarns and the coarser styles of tissues. In 1835, the weaving was altogether done by hand, and in the dwellings of the weavers. It then imported raw cotton from the English, French, and Dutch markets, and also *via* Trieste, and received from England cotton twist, chiefly of the higher numbers, cloths for printing, and various other tissues of that material. According to the report so often quoted above, the wages were from 7 to 10 batzen (20 to 25 cents) per day for spinners and those employed in the printing establishments. Youths, between 14 and 18 years, got from 3 to 5 batzen per day.

According to Weber's "Trade Statistics of Switzerland, Zurich, 1857," the number of cotton-spinning mills in Switzerland is now 132, and the number of weaving mills 48, distributed and furnished as follows:

CANTONS.	Mills.	Spindles.	Weaving Mills.	Looms.
Argovia	13	162,400	10	1,320
Basle	1	8,000	-------	-------
Berne	2	14,600	1	150
St. Gall	13	115,894	4	480
Glarus	11	139,140	10	1,890
Schaffhausen	2	10,300	1	150
Schwiz	6	59,500	2	440
Thurgan	4	23,100	4	454
Zurich	77	503,693	14	2,595
Zug	3	76,000	2	300
Total	132	1,112,303	48	7,779

At St. Gall, I was furnished, through the courtesy of Mr. Bergermann, the leading dealer in yarns and twist, with a table, carefully prepared by his deceased partner, in the year 1853, of all the spinning and weaving mills then known in Switzerland, with the places of location, number of spindles or looms, and names of proprietors.

At that period, the number of spinners was 138, with 907,799 spindles, and of weaving mills 31, with 3,727 looms, of which only six were distinct from spinneries. Mr. Bergermann estimated the increase in spindles, for the four years elapsed since the table was compiled, at 10 per cent.; and the statement furnished by Mr. Weber shows that he was within the mark. The apparent diminution in the number of mills, during the same period, can scarcely be real, as the business has unquestionably been prosperous and yielding fair profits on the capital invested.

The two most extensive cotton spinneries in Switzerland at the present day are those of Messrs. Henri Kunz and Henri Schmid, both of whom reside in the canton of Zurich. I had the pleasure and advantage of an interview with the first named, at his residence, in the town of Uster, some 15 miles from the city of Zurich, and he gave me some interesting details as to the manufacture.

The annual consumption in the different mills belonging to Mr. Kunz is between 6,000 and 7,000 bales of raw cotton; having, as he said, diminished somewhat under the great rise in prices. Of late, owing to an increasing demand for the finer numbers of cotton yarns, he has been using American and Egyptian cotton, in about equal quantities, and finds that the latter, though costing more, yields a greater profit for those descriptions of yarns. Of Sea Island he consumed but a very small quantity, and that only for the very finest numbers of yarns. But few mills (only three or four) in the country use it. Egyptian cotton of good middling quality or above, delivered at Uster, costs from 130 to 150 francs ($24 18 to $27 90) the 100 Swiss pounds; while American, of similar grades, costs from 10 francs ($1 86) to 15 francs ($2 79) less for the same weight. The Swiss pound is 10 per cent. heavier than the English. Egyptian bales weigh from 350 to 500 Swiss pounds. On American cotton the waste is, he says, about 12 to 15 per cent.; on Egyptian, which is not so clean, it is fully one per cent. more. Surat cotton is only used when American and Egyptian reach very high prices, while Brazilian is scarcely known.

The duties levied on the raw material are but insignificant, and are less than the road and bridge tolls used to be when each canton had its own custom-house; and consumption is not affected by them in the least. Mr. Kunz purchases the bulk of his raw material at Liverpool, as he gives limited orders, and wishes to keep them, as far as practicable, under his control, which he could not do in the remoter American markets. When he does buy at American ports, his agents are supplied with credits on London, Paris, or Basle, as may be most advisable at the period of purchase. The freight charges vary, so far as ship carriage is concerned, considerably, according to the facility of procuring vessels.

When cotton is purchased at Liverpool, it is transported in vessels to Mannheim, and there transferred to the railroads; the charges per 100 kilogrammes (220 pounds) to Zurich being from 6 francs 40 centimes to 6 francs 75 centimes.

The freight from Rotterdam, *via* Mannheim, is 4 francs 5 centimes to 4 francs 80 centimes the 100 kilogrammes. From Havre, the same weight will cost, by rail, 6 francs 40 centimes to 6 francs 50 centimes. From Marseilles, it will cost, if by rail, 6 francs 15 centimes to 6 francs 35 centimes; and if partially by water, 35 to 60 centimes less. In all these cases, the duty of 30 centimes per 100 kilogrammes is not included.

Mr. Henri Schmid very courteously replied to the various questions asked of him. His annual consumption of raw material is about 6,000 quintals, (110 pounds,) or 660,000 pounds, of which only one-sixth is of Egyptian growth, which is imported by way of Trieste. The remainder is of American, Georgia, and Louisiana, and comes by way of Havre or Marseilles. He estimates the cost of transportation to the factory as being equal to 30 per cent. on the purchase price; there being but little difference between the various ports in this respect, with the exception of Havre, through which the charges do not exceed 20 per cent.

Mr. Schmid has several spinning or weaving mills, giving employment to some 800 hands, whose average wages are 1 franc 40 centimes per diem, and the yearly value of their products bring 1,000,000 francs, or $186,000. Of the yarns spun, the far greater portion is woven on the spot. Some go to Eastern Switzerland, and a small quantity to the German markets. The numbers spun range from 20 to 200 of the English system. Of tissues, the chief production is of calicoes (yarns, 40 to 50) and jaconet muslins. The annual production is 1,600,000 ells, of the value of 500,000 francs, ($93,000,) for all of which there is a good home market. When he buys in the United States, his agents have credits on London or Paris, at 60 days' sight, subject to prevailing rates of exchange on the last-named city, which generally range from 5 francs 15 centimes to 5 francs 30 centimes to the dollar. Purchases at Alexandria are paid for in a similar manner, though the rates of exchange vary in that case between 5 francs and 5 francs 15 centimes to the dollar. Mr. Schmid estimates the average waste on American cotton, according to grade, at from 10 to 20 per cent. It is, as a general rule, less than that in other varieties of the same classification, though it may be sometimes more. The waste of American is in greater demand than that of Egyptian or Indian cotton. He agrees with all other spinners from whom I have had any information, that the duty on the raw material is too small to affect consumption.

At Zurich, a leading merchant and cotton buyer informed me that at least nine-tenths of the consumption of cotton in Switzerland was of the growth of the United States; there being but a small proportion of Egyptian, and still less of Brazilian or East Indian called for. The Swiss manufacturers, with whom capital is generally abundant, have availed themselves of all the latest inventions and improvements

in machinery, both for spinning and weaving; and their establishments are, for the most part, models as to neatness, order and skill.

The little town of Watwyl, built high up among the spurs of the Alps, is the scene of an active and prosperous industry. I had the pleasure of making the acquaintance of the two leading firms of Abram Raschle and J. Rod Raschle & Co., to each of whom I am indebted for courteous reception and readily furnished information as to the condition of the cotton manufacture at Watwyl.

Mr. Abram Raschle carries on the three branches of spinning, weaving and dyeing. Three-fourths of the raw cotton consumed in his mills are of the growth of the United States, and of ordinary grades; the other fourth is of Egyptian growth. His markets are the United States, (which is the chief,) the Levant, the East Indies—the places to which his fabrics go being Singapore, Manilla, Calcutta, and Bombay, and Italy, which takes about one-third of his manufactures.

The waste varies in spinning from 6 per cent. to 10 per cent. The numbers of yarns spun range from 40 to 60. Unbleached, these yarns are worth 3 francs (56 cents) for 40's; and 4 francs (74 cents) per pound for 60's. His looms are all worked by hand, and the number of hands employed by him ranges from 600 to 800. In 1856, the value of the products of his mills was 1,000,000 francs, ($186,000,) the whole of which went to foreign markets.

The establishment of Messrs. J. Rod Raschle & Co. are more extensive than those of Mr. Abram Raschle. They use but very little Egyptian or Surat cottons; the great bulk being of the growth of the United States, and of the variety which they term "Louisiana."

The tissues principally produced at Watwyl are ginghams, checks, madras handkerchiefs, printanieres, and striped goods. The printanieres for Turkey and the Levant are of fine styles, as are many of the ginghams. For the East Indies, the styles are cheap and heavy. Gaily colored shawls and handkerchiefs, with Turkey red grounds and light figures, are also manufactured to a considerable extent. The calicoes and other stuffs demanded by the home market are for the most part woven in the houses of the different families, scarcely one of which is without a loom and weaver. These two firms have their agents at New York and other cities, and their invoices are made up on orders transmitted through them.

The small though very wealthy city of St. Gall, the highest town of any importance in Europe above the level of the sea, is the centre of the manufactures of fine muslins and embroideries. To the firm of Holderegger & Zellwegger, who carry on a large business in those articles, I was indebted for the kindest reception and the most civil attentions during my stay in the town. There is but little manufacturing carried on in St. Gall itself, the business being mostly in the hands of small and enterprising capitalists, who enter into contracts with the merchants for furnishing within a given delay such quantities of embroideries or figured muslins as they may desire, and then have the work executed by the inhabitants of the district or canton in which they live, and which may be many miles away; or in some

instances, where these middlemen are well known for probity and punctuality, they are entrused by the merchants with a given quantity of thread or bobbinet, laces or tulles, to be converted into muslins or embroideries within a certain delay, to be paid for at an agreed rate, after deducting the value of the materials so furnished.

Two leagues from St. Gall, and still higher above the sea, is the beautiful and very cleanly little town of Hérisau, in the canton of Appenzell, which is also remarkable for its figured muslins and various articles of embroidered work, as well as for other tissues of cotton of greater or less fineness, according to the demand. Through the kindness of Mr. J. J. Neff, I had here the opportunity of witnessing the operation of weaving the finer and more costly styles of figured muslins. The looms used were, as I was informed, the invention of Mr. Neff. They are placed in well-lighted cellars, in order to preserve the moisture and pliability of the threads used, which is the general mode of the entire district. The yarns used for these styles of muslins are from Nos. 60 to 150 and 180. The weavers get from 8 francs to 10 francs the piece of 8 ells.

At St. Gall and Hérisau may be seen some of the finest and costliest figured or other muslins and embroideries for dress and curtains, which enjoy a superiority in all the markets of the civilized world, only disputed to a limited extent by the productions of Tarare, for which the French claim a superiority in the taste of the designs. The chief markets for the finest articles of these descriptions are England and the United States. The inferior goods go to the Levant, the East Indies, South America, &c. The bobbinet for these embroideries is imported from England, and comes from the famous looms of Nottingham.

At St. Gall are also found several bleaching and dressing mills. That belonging to Mr. Messmer is extensive and well worth a visit; the courteous proprietor taking every pains to point out and explain its various details. Here muslins, tulles, guipures, ginghams, printanieres, shawls, and handkerchiefs are either bleached, dyed, printed, washed, sized or folded, pressed, marked and packed, ready for the various markets to which they are destined. Many of the processes are highly interesting, particularly those for the dyeing of muslins and embroideries by steam, in order to preserve the pliability of the threads.

The wages paid in these establishments range from 80 centimes to 1 franc 50 centimes per day for women, and from 2 francs to 3 francs for men.

The working day is 14 hours, and in the winter it is not uncommon for the hands to work from 5 o'clock a. m. to midnight, with customary intermissions for meals. In this portion, at least, of Switzerland, children begin to work in the factories at the age of ten, and, in some instances, even six years. It is obligatory on the employer to permit them to attend school, at fixed hours, daily, until they reach twelve years, and once or twice a week afterwards, until they are fourteen.

Their wages are very small, not exceeding 15 centimes—something

under 5 cents—per day, when they first enter the mill, and for some time afterwards.

The stuffs printed at St. Gall are of both Swiss and English fabrication, no little of "grey cloth" being imported from the latter to be converted into colored goods. For the markets of Constantinople and the Levant, great quantities of gaily colored articles, such as shawls and handkerchiefs, mostly on Turkey red grounds, are preferred. For Wallachia and the other markets on the lower Danube graver tints are preferred; which is also the case with the goods sent to Spain and Italy.

All these tissues are of the lower qualities of cotton, the yarns used being Nos. 40 to 80, for warp, and 60 to 100, for woof; they are also, for the most part, rather flimsy in texture. For robes, the muslins are of much finer quality, those of English fabrication being composed of yarns ranging from Nos. 80 to 140.

All descriptions of embroidery, in St. Gall and Appenzell, are done by hand, with the exception of some narrow insertions, for which machinery is employed.

For purposes of revenue from importations, Switzerland is divided into six arrondissements, or districts. The first consists of the cantons of Berne, Soleure, Basle (town and county), and Aargau; the second, of the cantons of Zurich, Schaffhausen and Thurgovia; the third, of the cantons of St. Gall and the Grisons; the fourth, of the cantons of Tessino; the fifth, of the cantons of Vaud and Neufchatel; and the sixth, of the cantons of Valais and Geneva.

The importations of cotton into the country by way of the North, the Northwest, and Northeast, may be assumed to be almost exclusively of American growth. Those by the East and South are, on the contrary, almost exclusively of Egyptian growth; while those of the Southwest are also Egyptian, with perhaps a small portion of American, shipped from New Orleans to Marseilles.

The table herewith presented, which is official, will show the annual import of cotton, yarns, and tissues, and duties paid thereon, together with the exports of the same, for the five years from 1852 to 1856, inclusive. It will be seen that the amount of cotton imported in 1852 was 27,396,420 pounds, and in 1856, 28,324,860 pounds. While the cotton exported in 1852 was 1,464,650 pounds, and in 1856, 1,773,200 pounds, with an annual average of 1,549,430 pounds.

The quantity of yarns and threads imported during the same period averaged 364,540 pounds; that exported, 1,671,560 pounds. The quantity of cotton tissues imported averaged 3,529,020 pounds, while the exports of the same averaged 15,788,960 pounds.

As for the future prospects of cotton manufacture in Switzerland, it may be said that though it is an inland country, without seaports or coal beds, and therefore obliged to pay an increased price for the raw material, as well as for the necessary fuel to convert it into yarns or tissues, there is, nevertheless, to be found abundance of capital and cheap labor, whereby those disadvantages are overcome to a considerable degree. The general diffusion of skill in handwork, aided

by the system of popular education, the frugal habits of the people, and the winters of eight months' duration, compelling the inhabitants to remain within doors, all contribute to make up for the disadvantages under which it otherwise labors; the influence of new inventions in machinery, and methods of saving fuel, must also be felt there as they have been elsewhere; while the more liberal modern systems which dispense raw materials and manufactures from it, *in transitu*, from the payment of duties to the countries through which they pass, place Switzerland more on a footing with maritime countries than might otherwise be the case. A still further increase in her importation and manufacture of cotton seems, therefore, altogether probable.

I cannot conclude this portion of my report without expressing my obligations for kind assistance or valuable information from our excellent minister at Berne, the Hon. Theodore S. Fay; to Mr. A. H. Goundie, the consul at Zurich, and to Messrs. Franschini and Frey, members of the federal council of the Swiss confederation. M. Franschini, in particular, manifested the warmest desire to afford me all possible information. He was a gentleman of accomplished manners and varied information, and the proceedings of the general assembly on the occasion of his sudden death showed the high esteem in which he was held by his countrymen.

Statement of cotton and cotton fabrics imported into or exported from Switzerland, from the year 1852 *to* 1856, *inclusive; weights and measures reduced to American standard.*

Description.	Years.	Duty per quintal of 110 lbs. or 50 French kilogrammes	IMPORTS. N. W. district: Basle.	N. dist.: Schaffhausen & Romanshorn.	E. dist.: Rorschach, Chur, and the Shulgen.	S. dist.: Chiasso and Magadins.	W. and S. W. dist.: Valois, Geneva, Vaud, & Neufchatel.	Total for year.	Yearly average.	Years.	Duty per quintal of 110 lbs.	EXPORTS. Total for year.	Yearly average.
			Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*			*Pounds.*	*Pounds.*
Cotton	1852	30 centimes..	19,065,310	3,465,000	3,630,660	3,190	832,260	27,396,420		1852	30 centimes..	1,464,650	
	1853	....do........	18,441,830	2,705,340	1,638,230	1,650	893,860	23,680,910		1853	....do........	1,676,950	
	1854	....do........	15,910,950	1,613,480	2,830,680	4,400	715,110	21,080,620	25,324,860	1854	....do........	1,133,550	1,549,430
	1855	....do........	19,890,750	1,673,540	4,112,680	76,126	532,730	26,28[illegible],820		1855	....do........	1,697,410	
	1856	....do........	21,678,360	1,665,180	4,725,828	11,110	494,450	28,580,310		1856	....do........	1,773,200	
Unbleached yarn and thread.	1852	37 centimes..	92,510	14,080	78,760	1,760	18,480	205,590		1852	30 centimes..	1,494,790	
	1853	....do........	29,590	13,750	15,510	550	7,590	66,990		1853	....do........	2,228,820	
	1854	....do........	49,390	11,110	35,860	990	10,890	108,240		1854	....do........	1,435,060	
	1855	....do........	76,120	23,650	11,000	2,530	60,720	174,020		1855	....do........	1,396,560	
	1856	....do........	107,030	1,870	7,810	990	10,560	128,260	364,540	1856	....do........	1,802,460	1,671,560
Bleached and dyed yarn and thread.	1852	56 centimes..	113,630	14,300	33,880	4,400	55,440	221,650		1852	30 centimes..		
	1853	....do........	102,960	11,220	33,110	3,630	60,720	211,640		1853	....do........		
	1854	....do........	97,680	7,700	34,210	4,290	55,660	199,540		1854	....do........	Inclu'd in the above.	
	1855	....do........	107,260	11,550	29,590	6,160	93,610	248,270		1855	....do........		
	1856	....do........	137,280	10,450	38,500	8,580	63,470	258,280		1856	....do........		
Unbleached cotton tissues.	1852	37 centimes..	489,390	335,500	86,680	88,220	62,810	1,062,600		1852	30 centimes..	15,088,590	
	1853	....do........	455,950	283,800	149,930	76,120	54,560	1,020,360		1853	....do........	15,114,330	
	1854	....do........	666,930	186,670	105,930	73,260	61,380	1,095,170		1854	....do........	14,024,120	
	1855	....do........	942,700	711,160	155,100	110,440	45,210	1,974,610		1855	....do........	17,213,360	
	1856	....do........	2,144,340	678,150	292,270	85,140	150,150	3,350,050	3,529,020	1856	....do........	18,154,070	15,788,960
Bleached, dyed or printed cotton tissues.	1852	$1 49 cents..	666,490	33,660	51,480	633,600	469,040	1,854,270		1852	30 centimes..		
	1853	....do........	653,950	45,980	56,870	504,970	510,510	1,776,280		1853	....do........		
	1854	....do........	633,600	47,630	56,320	384,230	475,860	1,597,640		1854	....do........	Inclu'd in the above.	
	1855	....do........	566,390	56,210	51,700	719,510	455,410	1,849,210		1855	....do........		
	1856	....do........	736,670	69,740	59,950	602,030	597,630	2,066,020		1856	....do........		
								146,091,770		Total		95,047,920	19,009,650
										Home consumption.		51,043,850	10,208,770
												146,049,770	29,218,420

NOTE.—The values of the imports and exports are not given, and much delay and difficulty would probably attend the effort to obtain them.

THE HANSE TOWNS.

Although none of it is consumed in their territories, the two free cities of Bremen and Hamburg receive annually a large and rapidly increasing amount of cotton, which is distributed thence into the States composing the Zollverein, Switzerland, Austria, Russia, and Sweden. In this, therefore, as well as in other commercial aspects, the present condition and future prospects of their trade becomes a question of high interest to American statesmen.

It was my good fortune to meet, in both those cities, in the persons of the officers and members of their respective chambers of commerce, gentlemen who honor their calling as merchants, and are distinguished for the extent and variety of their information concerning the commerce of the world. Having a more extensive trade than Hamburg with our country, the city of Bremen, by the greater certainty of remunerative round voyages, offers perhaps greater facilities, as an importing point, to the consumers of the interior than the first named. Her merchants, too, have long appreciated the value of a direct trade with us, and have labored with persevering zeal and liberality to obtain their full share of its profits and advantages.

The cheapness of transportation into her port of the raw material, enables Bremen to compete successfully in the supply of the spinning mills at Vienna, even with Triest, which is much nearer, and which is now connected with the capital by an uninterrupted line of railroad. The principal cause of this is the great difficulty of obtaining return freights for the ships which take cargoes of cotton to Trieste, while at Bremen, either cargo or full complements of passengers to the United States are, in general, readily found.

The liberal policy of the city with regard to port charges, and the facilities which it offers in the way of docks, and the abundance of labor for the cheap discharge and taking in of cargoes, have also had their effect upon the growth of its trade.

The following communication from Mr. E. Klugkist, the president of the Bremen Chamber of Commerce, with its accompanying tables, exhibit clearly the movement of the trade of that port, in cotton, yarn, tissues, and other fabrics, for the period of five years, beginning with 1852 and ending with 1856.

The importation of cotton has swollen from 8,635,196 Bremen pounds, 100 of which are equal to 109$\frac{4}{5}$ of our own, and a value of 1,220,891 Louis d'or Thalers, equal to 78$\frac{4}{5}$ cents in the first named year, to 41,557,005 Bremen pounds, and the value of 6,898,559 Louis d'or Thalers in 1856.

Your particular attention is respectfully called to the answer of Mr. Klugkist to the tenth interrogatory; as it embodies the views which his high commercial position and experience have enabled him to form, as to the causes which may operate, either to increase or diminish the direct trade between Bremen and the United States.

BREMEN, *September* 2, 1857.

SIR: I have the pleasure of handing to you, inclosed, the reply to the questions put by your favor of 18th July, which it is hoped will answer your purposes.

You will also meet with some suggestions pointing to obstacles whose bearing, in the opinion of the Chamber of Commerce, is of vital influence on the commercial intercourse between the German ports and those of the United States, which is capable of much greater extension, if allowed to develop itself on its own merits.

Any further information is at your service on this subject, and adding the assurance of high esteem, I have the honor to be—

Your obedient servant,

E. KLUGKIST.

JOHN CLAIBORNE, Esq.

Answers to questions put by Mr. Claiborne.

Question 1. The quantity of cotton annually imported into Bremen, the countries of its growth, and the ports whence it is so shipped to this port, is answered by annexed statement, page 1.

Question 2. The freight and charges paid on such cotton, and its value on arrival?

Answer. The value is stated, also, on page 1.

It is composed of the invoice amount at the ports of shipment, with shipping, charges, and commission, adding freight and insurance.

The freight from the United States is subject to great fluctuations, from $\frac{1}{4}$ to 2 cents per 100 pounds. It is, generally, fully as low, and lower to Bremen than to Liverpool, on account of the very low port charges here. From Bombay, the freight is about £4 per 50 cubic feet.

Question 3. How much, if any, of the said cotton is consumed in Bremen, and how much distributed thence into other territory, specifying the different countries, the amount sent to each, and the duties and charges of every nature with which it is burdened in the transit?

Answer. Consumption in Bremen is quite trifling. The countries which draw this supply from Bremen are specified on page 2 of statement. There is levied a transit duty of one-half cent per 100 pounds in Bremen; the other charges are only those which are combined with every business transaction—say weighing, transporting from ship to railroad, and the small commission for doing this business.

Question 4. Are the duties or charges sufficiently high to lessen the consumption of cotton or cotton fabrics, in any one of the States or Territories so supplied? if so, specify such States or Territories, and the government or corporation by which the duties or charges are laid and collected?

Answer. The duty on cotton fabrics is high both in the Zollverein and Austria, to which countries the bulk of the cotton imported in Bremen is exported, but on yarn low; and as inland manufactures

are sufficiently advanced, this duty does probably not lessen consumption. There is a transit duty on cotton passing the Zollverein, if to Austria, of $3\frac{1}{2}$ per cent. per 100 pounds; other parts, 5 per cent. per 100 pounds—which proves very injurious, as by sending cotton to Switzerland by way of Antwerp or France, to Austria by way of Triest, it can be avoided, thus giving the merchants in Liverpool and London an advantage over those in Bremen and Hamburg, strengthening the supremacy which Liverpool has already in the cotton trade. It would materially assist the German markets, in their efforts to make themselves independent, if this unnatural transit duty would be done away with.

Question 5. The quantity of cotton yarn annually imported, the country or countries whence it is brought, its value per pound, according to numbers, and the place or places where sent from Bremen?

Answer. Is answered by statement, page 3. The numbers of the yarns cannot be given. Exports of the same are found at page 4.

Question 6. The amount and value of cotton or mixed cotton tissues or fabrics annually imported, the countries whence it comes, the duties and charges paid on it, and its value in this market?

Answer. Is answered by statement, page 5. There is no duty here whatever on the sale, and they can be imported by land from any port. There is not, therefore, a method of ascertaining the different kinds, as no entry is made.

Question 7. The amount and value of cotton or mixed cotton tissues or fabrics annually exported, and the countries to which it goes?

Answer. Is answered by statement, page 6. From the causes alluded to, question sixth, this information cannot be more explicit. If exported again, a transit duty of half a cent per 100 pounds is also levied, as on raw cotton.

Question 8. The course of exchange which attends the purchase of cotton or fabrics for this market?

Answer. Cotton purchases are generally made in the United States by drawing, against the amount, bills on Bremen. The exchange varies, and has, during the last years, been from 70 to 80 cents per Rix Dollar.

Question 9. What articles of production or manufacture does Bremen receive from the various countries which she supplies with cotton, in exchange for such supplies?

Answer. Cotton consumers pay with produce or manufactures which are sent here for sale. There is a great inland trade going on, too manifold to be specified.

Question 10. In case of the entire supply of American cotton which is taken by Bremen, or the countries which here obtain their supplies, coming direct from America, what articles of domestic production or manufacture could be exchanged against such cotton?

Answer. So far, the United States has been the country which supplied the cotton; but owing to its increasing value, efforts are making to get supplies from the East Indies, and this year, about 20 per cent. imports will be Surat cotton, which, although selling $33\frac{1}{3}$ per cent. lower, pays a profit. It is not as good, but manufacturers

are compelled to resort to it, by the high rates of North American cotton.

Our imports from the United States are paid for by some kinds of German produce and a good deal of manufactures, among which form a prominent part—cloth, (woolen,) cotton goods, hosiery, silks, cigars, toys, glass, looking-glass plates, willow baskets, musical instruments, pianos, manufactures of porcelain, negro pipes, bottles and demijohns.

Nearly all these articles pay a pretty high duty, which curtails their consumption in the United States, and diminishes the consuming power of the lower classes, who produce these articles with us.

A reduction of the duties on such articles would materially increase the export trade to the United States, and the consumption of cotton, tobacco, rice, and other articles produced by the United States, in Germany.

It must be remarked that the value is computed here in Rix Dollars, having a value of 78 to 80 cents each—112 pounds American weight are equal to 102 pounds in Bremen.

HAMBURG.

With a much larger population and a proportionately greater capital upon which to base her commerce than her sister city, Hamburg does not seem to have appreciated to the same extent as Bremen the value and importance of a direct trade with the United States. Her ships, like those of Great Britain and our own country, are found in every quarter of the globe, as her merchants of the present generation do not appear to have lost in any degree the spirit of enterprise and commercial adventure which has characterized their ancestors through many generations. That she should continue to receive indirectly the greater part of her imports of so important an article of consumption as cotton, is difficult of explanation with persons uninformed as to the nature of her financial combinations.

The accompanying official statements, in which the weights are reduced to our standard, furnished through the courtesy of Dr. Soetbeer, the secretary of the Chamber of Commerce, will show that, in the year 1855, the last for which any commercial statement had been published, at the period of my visit, the importation of cotton from the United States was 6,114,320 pounds, while that *via* Great Britain was 31,381,960 pounds, or more than five times as large. The fact that the far greater portion of this importation by way of Great Britain was of American growth, will enable you to see how vast must be the addition to the price of the bulk of the raw material to the German spinners and mill owners, by the existing system of trade, as they receive their supplies burdened, at the very least, with two sets of charges for freight and commissions to brokers, agents, and bankers, instead of but a single one. A leading banker and merchant of Hamburg, in explanation of this state of things, said to me that it had grown up and continued to exist, mainly on account of the absence

in the United States markets of an extended system of credits, such as could be obtained in England; and he also regarded the plan of short payments, enforced in our markets, as being a very considerable obstacle to additional consumption in Continental Europe, which, he argued, would increase far more rapidly, could longer credit than three months (that being about the available limit under present circumstances) be obtained by the purchaser, as could be done inthe English markets, and but for which circumstance the amount of trade in cotton, so far as Hamburg was concerned, would soon change into a more direct channel.

The value of direct trade with us is, however, much more appreciated in Hamburg at this time than has hitherto been the case, and with the example and immense commercial progress of Bremen in that respect, before them, as an illustration of the great advantages likely to flow from it, if properly fostered, they are turning their eyes beyond the marts of London and Liverpool to those of New York and New Orleans, anxious to secure, if practicable, for themselves the only profits on that portion of our products which is consumed in the interior States of Germany ; and, at the same time, to endeavor, by the establishment of a steady, cheap, and well supplied market, to command, to a greater degree than at present, the supply of our raw materials to Northern Europe.

The communication of Dr. Soetbeer will show that there are no duties levied on cotton imported into Hamburg ; the only contribution of that nature being the toll exacted by the Hanoverian government upon the cargoes of all vessels passing the town of Stade ; a tax of which the merchants and shipmasters of the city complain with great show of reason, alleging that it is in clear violation of the treaty of Vienna, and so far also as American ships are concerned, of the terms of our existing treaty with that power. This course of policy on the part of Hanover is the more obnoxious, because the entire charge of providing for the safe and convenient navigation of the Elbe, and the keeping up of the lights, buoys, &c., falls upon Hamburg alone ; and from the fact also that the Hanoverian government levies no similar toll on the ships and property of its own subjects.

It will be seen that the raw cotton imported into Hamburg is distributed thence by water or railroad communication in Saxony, Bohemia, Austria, and of late years, since the railroads have afforded sufficient facilities for cheap transportation, into Bavaria and Switzerland. It is through Hamburg, as I was informed, that Saxony, which may be considered as taking the lead among the German States in the cotton manufacture, obtains the bulk of her supply of the raw material, and it is through that port and Bremen that the various fabrics and tissues into which the article is converted in the interior find their way into the most remote markets of the world.

It is believed that the cost of interior transportation will still further decline with the progress and development of the German system of railroads, and improvements in river navigation on the Elbe and the Weser, and that there is every prospect of a steady and growing demand for raw material for manfacturing purposes, from the

interior, and particularly from quarters where, owing to the absence, until within a comparatively recent period, of the means of rapid and easy communication with the sea-ports, manufacturing industry was not so inviting to Continental capital, nor capable of that progress and development which is thought to be now before it.

As Dr. Soetbeer does not give the values of the cotton and yarn imported into and exported from Hamburg, the following statement, which also includes cotton manufactured goods, is compiled from the official statement of the trade of the city for the year 1855, published in 1856; that for the latter year not having been printed at the period of my visit.

The imports, exports, and value of the same articles for the year 1854 are also given:

1855.—Value of cotton imported	$4,447,145
" Value of yarn and twist imported	10,319,393
" Value of manufactured goods imported	8,957,257
Total	23,723,795

1855.—Value of cotton exported	$4,858,088
" Value of yarn and twist exported	11,627,162
" Value of manufactured goods exported	8,682,594
Total	25,157,844

1854.—Value of cotton imported	$5,351,105
" Value of yarn and twist imported	8,474,624
" Value of manufactured goods imported	8,828,161
Total	22,653,890

1854.—Value of cotton exported	$3,724,553
" Value of yarn and twist exported	8,059,065
" Value of manufactured goods exported	7,450,310
Total	19,233,928

HAMBURG, *August* 24, 1857.

SIR: In reply to your esteemed favor of the 24th of July, containing several questions about our cotton trade, I respectfully beg leave to give the following explanations:

1. I refer to the annexed tables.

The principal ports whence it was shipped are New York and New Orleans; some cargoes came from Mobile and Charleston.

2. The rate of freight from New Orleans and Mobile fluctuated between $\frac{3}{4}$ and $2\frac{1}{4}$ cents per pound; $1\frac{1}{4}$ and $1\frac{1}{2}$ cents per pound is about an average. From New York the usual rate of freight is between $\frac{1}{2}$ and $\frac{3}{4}$ cents per pound. The charges attending an invoice to Hamburg are light, and by the taking off of all duties, less than to any other continental ports. The charges here are—Stade duties (levied by the Hanoverian government,)

U. B. 24 g. gr. = 1 mark current, $\frac{3}{4}$ groschen per 100 pounds.
Delivery, &c., 8 B. per bale.
Brokerage, $\frac{5}{6}$ per cent,
Commission, 2 per cent.

3. The whole of our importation goes to the interior; chiefly to Saxony, Bohemia, Austria, and latterly to Bavaria and Switzerland. A good deal of the finer qualities, fully good "middling," to fully "fair," is going to Russia, and some to Sweden and Poland. All classifications are quite ready of sale, but "middling" to "middling fair" are the most sought for.

4. All Hamburg duties on cotton have been removed, only the Stade duty; a passage toll laid by Hanover remains.

5. Of cotton yarns and twist, about 35,000 bales touch our port, in transit from England to the interior, per annum; none is sold or brought here, as we have no market for the article. There are no duties besides the Stade duties (11 B. banco per bale.)

6. Our importation and exportation of the fabrics or tissues of cotton, &c., reach a great extent, but we cannot give the particular statistics.

7. Against shipment of cotton to our markets, reimbursement is taken from the South of the United States, on New York, by sight drafts, at from 2 per cent. discount to 2 per cent. premium, but usually at 1 per cent. discount; and from New York, drafts are issued at 60 days sight, usually at the exchange of $36\frac{1}{4}$ to $36\frac{3}{4}$ cents per 1 B. banco.

8. Fabrics, tissues, &c., are the chief articles returned from the interior for supplies of cotton; and our exportation of such goods, &c., reaches so high an amount that the most of the remittances made from the interior to other cotton markets consist in drafts on Hamburg against the excess of goods sent hither for shipment.

9. All kinds of goods, fabrics, &c., are shipped to the United States from our port, overreaching by far the amount of our importation of cotton.

With high respect, I remain, sir, your most obedient servant,

AD. SOETBEER.

Mr. JOHN CLAIBORNE,
Special Agent, &c.

Statement of the imports and value of cotton into Bremen, in the years named, furnished by Mr. Klugkist, and referred to by him as page 1 in his answers. Weights and values reduced to the standard of the United States.

IMPORTS OF COTTON.	1852.		1853.		1854.		1855.		1856.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Oldenburg									105,482	$9,254 70
Hamburg							134,844	$4,247 77		
Egypt					210,816	$25,200 00	338,133	39,434 06		
Great Britain	269,249	$23,803 76	232,128	$19,881 22	417,713	34,298 77	1,007,193	86,095 01	1,790,107	164,344 16
New York	1,763,713	176,309 45	3,062,240	358,714 12	2,894,164	319,993 53	5,672,383	690,977 70	3,416,288	424,654 65
Philadelphia					174,252	23,081 32				
Baltimore			13,771	1,745 88						
Charleston, S. C.	1,442,982	149,721 86	2,284,644	277,014 15	699,005	81,690 62	1,371,261	138,058 20	7,682,237	916,160 05
Savannah	227,280	26,760 03	289,510	35,549 32			1,230,485	122,756 28	395.397	48,636 78
Mobile					1,213,243	146,534 06	687,776	90,575 10	3,984,789	443,661 75
New Orleans	5,056,020	518,230 12	5,618,019	609,023 37	15,673,451	1,802,701 68	13,682,492	1,560,812 40	24,881,569	3,061,817 32
Galveston	541,232	58,868 27	1,055,175	119,202 30	1,563,601	170,515 80	1,558,621	173,299 61	2,396,930	279,412 87
Hayti	23,398	1,890 00	8,388	687 48	24,650	2,466 45	124,977	11,492 77	133,863	12,507 07
Porto Rico	5,420	567 00			90,920	12,488 17	15,256	2,090 81	15,262	1,968 75
Venezuela	19,225	1,811 25	54,370	5,770 01	31,073	3,622 50	76,371	8,228 58	48,123	5,770 80
Brazil	58,468	6,466 95			33,580	3,390 97	92,817	12,261 37	47,492	6,480 33
Bombay									636,431	58,366 35
Other countries	13,472	922 95	39,005	3,268 12	21,371	1,613 58	25,574	2,330 21	5,615	597 60
Total	9,470,459	961,351 64	12,657,250	1,430,855 97	23,047,839	2,627,597 45	26,018,183	2,942,659 87	45,539,585	5,432,615 18

Statement of cotton exported from Bremen during the years specified, referred to by Mr. Klugkist, in his answer to the 3d interrogatory, as page 2.

COTTON EXPORTED TO—	1852.		1853.		1854.		1855.		1856.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Hanover	228,939	$26,063 88	141,153	$15,953 17	264,559	$28,312 98	1,077,989	$121,854 60	2,230,645	$252,860 73
Oldenburg	178,778	16,865 88	117,378	12,815 77	433,626	46,518 41	189,764	17,880 18	449,108	50,025 93
Prussia	1,255,989	141,202 68	1,529,375	180,933 65	3,763,389	434,811 82	3,412,411	403,369 31	6,607,584	836,676 88
Saxony	5,541,761	614,966 62	5,441,231	659,148 52	6,900,789	811,900 68	9,625,191	1,146,314 88	11,298,901	1,453,242 26
Brunswick	82,057	8,229 37	24,011	2,375 10	8,767	934 76	28,975	3,156 30	33,690	3,370 50
Bavaria	182,979	20,707 82	1,902,943	227,138 62	4,222,713	501,363 45	4,455,273	527,843 13	9,690,919	1,242,771 86
Baden	32,619	3,346 08	347,284	42,001 21	141,121	16,254 78	72,166	8,938 12	200,789	26,574 18
Wirtemberg	132,217	13,263 62	85,515	11,369 92	148,337	17,171 43	543,325	63,826 87	740,560	95,711 17
Hamburg	----------	----------	105,718	14,026 95	35,353	3,675 26	577,649	74,560 50	332,069	43,192 80
Russia and Poland	37,396	4,560 36	289,919	38,687 51	875,438	114,623 77	986,474	124,168 27	5,082,307	668,370 15
Sweden	----------	----------	----------	----------	----------	----------	46,848	5,599 90	15,756	2,050 65
Norway	----------	----------	----------	----------	----------	----------	----------	----------	194,113	25,046 43
Holland	----------	----------	42,523	5,242 38	----------	----------	8,014	826 08	11,004	1,452 15
France	----------	----------	----------	----------	----------	----------	49,410	6,142 50	----------	----------
Switzerland	468,258	52,319 13	45,374	5,142 37	88,031	10,417 83	93,597	10,292 62	428,923	56,964 60
Austria	1,643,606	179,784 67	1,436,316	178,218 33	2,871,141	337,623 30	5,527,142	662,441 85	9,521,015	1,207,152 41
Great Britain	----------	----------	54,883	3,301 20	----------	----------	----------	----------	101,115	12,207 82
Other countries	32,436	3,713 06	8,819	1,091 47	12,427	1,397 81	15,831	1,868 73	41,085	4,949 43
Total	9,817,035	1,085,013 17	11,572,442	1,397,446 17	19,765,691	2,325,006 28	26,710,059	3,179,083 84	46,980,583	5,981,619 95

Statement of cotton yarns imported into Bremen during the years specified, referred to by Mr. Klugkist, in his answer to the 5th interrogatory, as page 3. Values and weights reduced to the United States standard.

COTTON YARNS IMPORTED FROM—	1852.		1853.		1854.		1855.		1856.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Hanover	12,245	$1,938 03	8,454	$1,941 97	7,751	$2,571 18	14,061	$5,565 26	11,194	$1,783 68
Oldenburg	215,541	28,341 33	141,859	20,349 00	573,303	82,237 83	732,078	116,679 93	863,734	137,662 87
Prussia	26,958	14,912 88	45,599	17,247 82	21,394	8,662 50	21,930	10,802 92	30,770	13,235 51
Saxony	4,057	1,646 90	2,804	1,370 25	3,398	1,242 67	4,172	1,734 07	2,816	1,137 15
Brunswick	1,229	415 80	1,899	613 46	2,865	1,027 68	1,886	759 93	2,584	1,020 60
Hamburg	29,955	5,273 88	21,082	4,076 10	11,880	2,623 95	20,473	3,597 30	8,724	1,641 15
Great Britain	457,614	75,417 30	445,289	79,901 32	844,948	137,547 11	1,924,446	344,616 30	3,542,091	667,819 68
Other countries	139	89 77	1,320	162 22	490	153 56	612	241 76	552	219 80
Total	747,738	128,035 89	668,306	125.662 14	1,466,029	236,066 48	2,719,658	483,997 47	4,462,465	824,520 44

Statement of cotton yarns exported from Bremen during the years specified, referred to by Mr. Klugkist, in his answer to the 5th interrogatory, as page 4. Values and weights reduced to the United States standard.

COTTON YARNS EXPORTED TO—	1852.		1853.		1854.		1855.		1856.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Hanover	379,941	$59,057 77	342,694	$57,963 15	482,455	$80,302 95	551,215	$98,473 72	829,716	$162,208 46
Oldenburg	15,092	4,660 42	17,837	5,462 10	21,554	5,456 58	17,905	7,318 23	12,632	3,913 87
Prussia	80,077	13,290 63	102,589	17,605 35	723,760	108,739 57	1,566,817	267,142 83	2,230,074	396,264 48
Saxony	1,555	259 08			8,440	1,242 67	58,622	10,418 62	1,055,131	198,630 33
Brunswick	76,577	12,772 46	38,376	6,860 70	139,337	23,580 11	113,174	20,292 30	92,763	18,277 87
Duchy of Saxe	13,822	2,294 02	30,131	5,403 03	3,708	628 42	50,312	9,021 60	86,570	16,097 28
Bavaria	5,633	740 25			929	157 50	21,833	3,914 66	26,662	5,019 52
Hesse Darmstadt	14,011	2,348 08	8,290	1,486 01			1,251	224 51		
Kurhesse	23,465	3,915 37	29,235	5,242 38	28,450	4,817 92	36,239	6,497 66	34,738	6,277 21
Austria					1,054	189 00	240,594	43,139 25	47,566	8,479 80
United States	12,769	7,469 43	18,289	8,101 80	10,808	4,308 41	9,181	3,839 85	19,523	8,037 22
Other countries	4,368	752 06	17,189	5,925 15	16,581	2,810 58	4,893	1,045 80	6,775	1,541 13
Total	627,310	107,549 57	604,630	114,049 67	1,437,076	232,233 71	2,672 036	471,329 03	4,442,150	824,747 17

Cotton manufactured goods imported into Bremen during the years specified, referred to by Mr. Klugkist, in his answers to questions 6 and 7, as page 5.

Whence.	1852.		1853.		1854.		1855.		1856.	
	Packages.	Value.	Packages.	Value.	Packages	Value.	Packages.	Value.	Packages.	Value.
Hanover	1,928	$99,549	2,493	$152,342	1,665	$74,177	1,587	$65,005	1,747	$77,387
Oldenburg	1,641	76,020	1,310	75,795	1,245	107,039	1,611	129,156	1,458	124,145
Prussia	1,189	180,653	1,494	291,493	1,594	210,226	1,302	114,474	1,669	195,498
Saxony	13,555	1,679,337	15,292	2,368,913	13,535	1,912,658	13,169	1,653,189	15,647	2,244,189
Brunswick	94	7,903	77	5,110	64	4,149	60	3,929	52	4,075
Duchy of Saxe	11	669	32	2,330	69	4,782	23	2,372	70	8,559
Bavaria	71	7,587	493	61,274	604	73,074	506	65,608	611	99,242
Wirtemberg	----	----	2	79	56	9,927	62	10,434	25	3,887
Frankfort on the Maine	----	----	----	----	6	551	8	1,017	83	13,928
Hesse Darmstadt	2	183	1	232	12	2,126	4	543	19	2,955
Kurhesse	9	773	10	1,410	16	1,610	26	2,154	47	2,992
Hamburg	111	10,540	573	87,389	401	46,585	321	49,610	219	19,192
Holland	79	6,121	27	1,704	----	----	2	21	----	----
Great Britain	60	16,004	205	50,326	233	47,441	351	76,891	113	21,819
Other countries	6	----	31	----	28	2,670	31	2,511	31	4,504
Total	18,754	2,085,319	22,040	3,098,379	19,528	2,497,015	19,063	2,176,914	21,801	2,821,372

Cotton manufactured goods exported from Bremen during the years specified, referred to by Mr. Klugkist, in his answers to questions 6 and 7, as page 6.

WHITHER.	1852.		1853.		1854.		1855.		1856.	
	Packages.	Value.	Packages.	Value.	Packages.	Value.	Packages.	Value.	Packages.	Value.
Hanover	2,816	$172,586	2,992	$173,813	1,776	$79,173	2,075	$101,319	2,077	$97,614
Oldenburg	355	18,564	340	23,503	428	27,746	623	40,528	602	33,149
Prussia	2	224	5	105	413	62,940	421	75,376	454	81,509
Hamburg	362	27,050	393	31,443	231	14,514	113	7,733	53	2,544
Austria	--------	--------	--------	--------	--------	--------	155	39,745	1	39
United States	13,386	1,736,099	16,506	2,507,707	14,332	2,070,030	13,059	1,752,895	16,416	2,413,600
Mexico	216	30,758	292	51,758	179	20,922	154	14,441	157	17,534
Cuba	16	1,771	37	4,179	95	9,306	33	5,937	37	6,059
Hayti	185	20,948	119	13,820	355	44,921	152	18,950	118	14,175
Venezuela	88	10,799	68	7,803	105	12,703	234	28,678	192	21,698
Singapore	--------	--------	--------	--------	--------	--------	--------	--------	81	18,291
Java	64	10,518	149	29,665	--------	--------	12	3,434	80	13,926
Sandwich Islands	--------	--------	27	4,051	150	31,902	56	7,881	41	4,706
Bremerhaven	159	8,181	197	14,129	298	17,594	220	13,943	185	9,631
Other countries	159	14,803	86	11,412	74	7,132	117	16,429	207	27,136
Total	17,808	2,054,301	21,211	2,873,388	18,436	2,208,883	17,434	2,127,339	20,701	2,761,611

Statement of cotton imported into Hamburg in the years named. Weights reduced to those of the United States.

WHENCE.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
United States	7,692,900	5,505,422	3,764,641	5,131,675	13,712,212	12,903,682	16,086,653	6,530,093
Brazil	98,704	193,340	123,343	177,063	97,508	118,259	192,741	320,667
Venezuela	96,824	119,135	61,774	134,557	507,824	440,336	271,996	216,889
Peru and Chili	61,355			4,773		119,680	106,864	
Great Britain	9,498,471	15,510,860	21,027,232	23,702,166	21,015,314	28,206,841	35,744,134	33,915,933
Netherlands	46,959	563,710	29,957	61,036			271,165	891,054
Bremen	51,210	18,262	23,143	217,829	13,125	162,837	6,310	602,191
France	54,136	2,018	66,130	326,541	309,890	354,359	42,378	112,449
Other countries	175,686	3,232,248	1,755,740	1,932,076	3,478,337	3,139,485	3,880,923	4,404,175
Total	17,776,245	25,144,995	26,851,960	31,687,716	39,134,210	45,445,479	56,603,155	47,083,451

Cotton exported from Hamburg in the years named.

WHITHER.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Germany, &c	18,500,024	24,365,041	25,614,185	29,217,041	35,985,031	37,784,686	48,814,078	43,541,345
North of Europe	2,269,994	2,280,596	1,709,451	2,722,011	3,701,626	3,309,387	6,271,716	4,006,730
Total	20,770,018	26,645,637	27,323,636	31,939,052	39,686,651	41,085,073	55,085,794	47,608,075

Cotton yarn and twist imported into Hamburg in the years named.

WHENCE.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Great Britain	32,783,908	33,383,140	43,821,898	39,814,599	39,226,123	36,337,350	42,050,737	46,254,379
Other countries	585,958	2,246,032	2,115,665	3,293,156	5,983,865	5,943,537	5,914,050	8,499,528
Total	33,369,866	40,629,172	45,937,563	43,107,755	45,209,988	42,280,887	47,964,787	54,753,907

NOTE.—The above are the latest official returns up to July, 1857. Du Fay & Co.'s Trade Report, (Manchester,) considered excellent authority, of October 31, 1857, furnishes a statement of the quantities, in yards and pounds, of cotton manufacture, yarn and twist, exported to the Hanse Towns for the first three-quarters of the years 1856 and 1857, as follows:

Cotton manufactured up to September 30, 1856	yards	47,120,029
Do do 1857	do	39,833,417
Cotton yarn and twist up to September 30, 1856	pounds	36,565,505
Do do 1857	do	37,824,700

Statement of the quantity and value of cotton exported from Hamburg, in 1855, *with the countries to which it was sent. Values and weights according to the United States standard.*

COUNTRIES.	Pounds.	Dollars.
Sweden	85,490	8,410
Prussia	34,808	2,713
Bremen and the Weser	139,950	3,815
Great Britain	82,652	8,372
France	21,311	2,548
Altona, &c.	1,394,150	129,535
Altona and Kiel railroad	101,532	11,872
Lubec	2,569,078	304,234
Berlin and Hamburg railroad	25,545,790	2,347,457
By wagons and boats	26,554	2,409
Harburg, and beyond	12,506,447	1,028,010
The upper Elbe	10,679,306	996,419
Total	53,147,068	4,845,884

ADDENDA.

BREMEN LEGATION,
Washington, February 13, 1858.

SIR: Knowing the interest taken by the department in collecting information that may stimulate home production, by pointing out the natural channels and avenues into which foreign demand must eventually lead American commerce, I take pleasure in transmitting to you a memoir on the consumption of cotton in the German Zollverein, which, founded on official and most reliable private sources, will serve to prove how rapidly the consumption of cotton is increasing in Germany, and the justness of the assumption that this increase will continue in the immediate future.

I avail myself of this opportunity to offer you the assurance of my very high consideration.

R. SCHLEIDEN.

HON. JACOB THOMPSON,
Secretary of the Interior of the United States,
Washington, D. C.

The consumption of cotton of the German Zollverein.

According to the treasury reports on the commerce and navigation of the United States, the exports of American cotton to Bremen and Hamburg during the last four financial years were as follows:

YEARS.	TO BREMEN.			TO HAMBURG.		
	Bales.	Pounds.	Value.	Bales.	Pounds.	Value.
1853–'54	....	23,959,656	$2,232,222	....	13,760,266	$1,304,138
1854–'55	51,648	22,661,173	2,020,438	18,672	8,148,818	761,572
1855–'56	103,054	46,456,809	4,238,497	34,192	15,609,844	1,469,753
1856–'57	71,165	34,378,685	4,356,418	22,720	10,524,075	1,311,935

Although the quantity exported during the last year was smaller than that shipped during the previous one, yet the increased value of the article makes up fully for the decreased quantity, the same having doubled during both of the last two years. In fact, Bremen and Hamburg import more American cotton than any other country, except Great Britain, France, and Spain. In order to appreciate how far this state of things rests on a sound basis, it seems fit to inquire into the wants of those countries which Nature itself has taught to look to the above ports as the proper markets for supplying themselves.

While there are about 3,250,000 spindles in France and about 21,000,000 in Great Britain, there were working at the beginning of the present year in the German Zollverein:

COUNTRIES.	Cotton manufactories.	With spindles.	Consuming bales of American cotton.	Bales of East India cotton.*
In Bavaria	16	316,700	29,800	5,800
In the kingdom of Saxony	133	554,646	34,200	34,000
In Prussia	20	289,000	22,500	9,000
In Baden	10	185,600	18,600	6,200
In Wirtemberg	12	119,000	11,950	3,700
In Hanover	1	48,800	3,000	3,000
In Oldenburg	4	20,400	1,200	3,200
Total	196	1,534,146	121,050	64,900

Grand total, 185,950 bales.

* We use here the expression "East India" cotton as a general term for all kinds spun in the Zollverein besides American cotton.

The manufacture will be increased during the present year by:

COUNTRIES.	Cotton manufactories.	Spindles.	To consume bales of American.	Bales of East India cotton.
In Bavaria	2	232,000	20,250	4,400
In Saxony	1	50,000	3,500	2,000
In Prussia	6	135,000	10,500	4,000
In Baden	1	25,000	1,500	----------
In Wirtemberg	----------	15,000	1,650	----------
In Hanover	1	7,000	----------	1,000
In Oldenburg	1	20,000	1,000	1,000
Total	12	484,000	38,300	12,400

Grand total, 50,700 bales.

There will be, therefore, in working order next year:

COUNTRIES.	Cotton manufactories.	Spindles.	To consume bales of American cotton.	Bales of East India cotton.	Total.
					Pounds.
In Bavaria	18	548,700	50,050	10,200	60,250
In Saxony	134	604,646	36,700	36,000	73,700
In Prussia	26	424,000	33,000	13,000	46,000
In Baden	11	210,600	20,100	6,200	26,300
In Wirtemberg	12	134,000	13,600	3,700	17,300
In Hanover	2	55,800	3,000	4,000	7,000
In Oldenburg	5	40,400	2,200	4,200	6,400
Total in Zollverein	208	2,018,146	158,650	77,300	235,950

In 1856, the number of spindles actually in operation within the German Zollverein was only 1,200,000, and the amount of cotton consumed 160,000 bales.

The above statement, which is brought down to the present day, shows the former number increased within two years to 1,534,000, and the cotton consumed to 186,000 bales, while these numbers will be further increased, during the present year, to—manufactories 208, spindles 2,018,146, and bales needed for consumption 235,950.

Furthermore, the Austrian empire, according to the last reliable statistics of the year 1851, numbered 208 cotton manufactories, with a total of 1,482,138 spindles, and of a consuming capacity of 130,000 bales.

Although it was impossible to gather newer dates from that quarter.

the increase since may be safely estimated at 15 per cent. Of those Austrian manufactories are situated:

COUNTRIES.	Manufactories.	Spindles.	Bales.
In Tyrol	20	195,000	17,000
In Bohemia	79	460,000	35,000
Total	99	655,000	52,000

The statistics of these two countries are of particular interest on account of the greater quantity of the raw materials needed by them, being imported by Bremen and Hamburg, and a considerable part of their manufactured articles being consumed in the Zollverein. But the manufactories of the other parts of Austria, although they do not sell much to the countries of the Zollverein, have lately commenced to import part of the raw materials needed by those northern ports, as the cheapest and speediest way of procuring them.

Great as the increase of the cotton manufacture has been throughout Germany, the fact of the continuing importation of English cotton goods, amounting, for the Zollverein alone, to 550,000 cwt. a year—the manufacture of which will require at least 175,000 bales—gives additional evidence of this branch of industry being capable of still more successful development; and, consequently, there is still a great field open for improving the direct cotton trade between the United States and Germany, by the way of Bremen and Hamburg. This is rendered less doubtful, as these sea-ports are already capable, in consequence of their extensive shipping, and of a general reduction in the rates of railroad freight throughout Germany, to supply to an important amount the wants of countries beyond the Zollverein. Among these countries, Austria and Switzerland are prominent, where there are respectively about 1,500,000 and 1,250,000 of spindles in operation, and where Bremen and Hamburg compete successfully with the ports of France, Belgium, and Holland; these, on the other hand, supplying part of those States of Germany, which, according to their situation, could be better provided by the German ports.

Comparing, therefore, the amount imported by foreign ports into the Zollverein, and that imported by German ports into foreign countries, Bremen and Hamburg are no doubt destined to import, in the course of time, at least, such a quantity of cotton as is required by the Zollverein, namely, 236,000 bales. For the present, however, the direct imports of Bremen and Hamburg fall about 90,000 bales short of this amount; these, during the year ending the 31st of December last, having been only as follows:

At Bremen	86,079	bales of American cotton.
	25,605	bales of East India cotton.
	533	bales of South American cotton.
	395	bales of West India cotton.
Total	112,612	bales.

At Hamburg	25,599	bales of American cotton.
	15,582	bales of East India cotton.
	1,033	bales of South American cotton.
	6,373	bales of West India cotton.
Total	48,587	bales.
At Bremen	112,612	bales.
Grand total	161,199	bales.

RUSSIA.

The empire of Russia has kept a nearly equal pace with the other Continental States in the increase of consumption and manufacture of cotton ; and her most enlightened statesmen seem fully to appreciate the importance of this great branch of industry, though some of them do not conceal their dissatisfaction at the inroads it has made upon the manufacture of flax, which is a raw material of domestic growth, while every pound of cotton is exotic.

A very interesting account of the history of the use and progress of the domestic manufacture of cotton, and the fluctuations to which it has been subject, either from financial or political causes, is to be found in the second volume of Prince Tégoborski's *Commentaries on the Productive Forces of Russia*, a work highly prized by his countrymen, and which is regarded as a standard authority on all subjects of which it treats.

Beginning by stating what he conceives to be the leading points of advantage or disadvantage to Russia from cotton manufactures and their continued increase, the author proceeds to a clear and succinct narrative of their establishment, and the progress which they had made up to the year 1852, from which the following statements are compiled :

The first spinning mill was established in 1823 ; and two years later, the only one of any importance in the country was that owned by the Government at Alexandrovsky, on the Neva, a few miles above St. Petersburg.

During the succeeding ten years, but little increase in the number of mills was evident ; and, in 1835, the importation of cotton reached only 200,000 poods, of 36 pounds each ; or 7,200,000 pounds ; the manufacture of fabrics reaching 800,000 poods, or 28,800,000 pounds, showing how much they still were dependent on other countries for supplies of yarns. At the time of the first spinning mill being put into operation, the Russian tariff absolutely prohibited the introduction of cotton prints, and, on plain cottons, duties ranging from 60 to more than 100 per cent. were imposed. The consequence was, that cotton manufacture "monopolized speculation, to the detriment of many other branches of industry ;" and its progress was rapid, as

is shown by the table of the triennial averages of importation of the raw material, and of twist, beginning with 1824:

YEARS.	Pounds of raw cotton.	Pounds of twist.
1824–'26	2,673,648	2,022,606
1827–'29	3,534,480	15,860,952
1830–'32	4,175,856	19,211,540
1833–'35	6,162,804	19,678,364
1836–'38	10,180,764	21,561,668
1839–'41	12,807,864	19,515,500
1842–'44	18,882,396	21,318,948
1845–'47	28,085,364	18,156,096
1848–'50	47,845,116	10,134,720
1851	52,585,632	5,685,516
1852	62,940,456	4,058,388

"Thus," says Prince Tégoborski, "we see that the importation of raw cotton has followed a continuously ascending movement, exhibiting in its latest results an augmentation in the proportion of 1 to 24; whilst that of twist, after nearly tripling, in the course of the first fifteen years, has fallen gradually to a third of the cypher of 1824–'26; and to less than a fifth of its culminating cypher of 1836–'38."

Taking the period of sixteen years—1834 to 1850—the increase in Russian cotton manufactures, as compared with that of France, was nearly as 3 to 2; compared to that of Austria, it was as 10 to 44; the duty on the raw material being raised in Russia from 5 to 6½ roubles per pood, while in Austria it has been lowered from 30, 60, and 81 florins, according to quality, to a uniform rate of 10 florins the centner. With the States of the Zollverein, the comparison was in favor of the latter, being in the proportion of 6 to 5. From the commencement, cotton yarn had been protected by a duty of 5 roubles ($3 75) the pood; but still the spinneries made little perceptible progress until 1842.

Among the other struggles undergone by the spinners was that of the impossibility of procuring, up to that date, proper machinery, the exportation of that of English manufacture being prohibited, and they had consequently to rely on the "defective" machinery of France or Belgium. At the period of the great commercial crisis of 1841–'42, the spinners at Moscow solicited and obtained from the government, as a temporary measure, an increase in the duty on cotton yarns, and it was accordingly raised to 6½ roubles ($4 88) the pood, at which point it remained at the time the author was writing. As will be seen hereafter, this rate has been greatly lowered by the tariff of 1857. This duty of 6½ roubles the pood was deemed equal in yarns of medium fineness, 20–40, to "the enormous rate of 60 per cent. and upwards, *ad valorem*," and gave a great impulse to the spinning mills; so that while in 1848–'50 they furnished 82 per cent. of the whole quantity of yarn used in the weaving industry of the country, they, in 1852, furnished all of it but about 7 per cent. But this

apparently prosperous state of affairs was nevertheless, in the view of Prince Tégoborski, accompanied with risks and inconveniences, for, as he observed, the heavy duty on yarn, while it had rendered the manufacturers independent, had also made fabrics dear, and "a host of speculators, working on borrowed capital, at a high rate of interest;" had started a number of ill-regulated establishments, which, without the bounty of a highly protective tariff, could not exist.

In quality, the mass of the yarns produced in Russia is of the lower numbers, 48, 50, being the highest; most spinners turn out Nos. 30 to 40 mule, and 20 to 30 water twist, those qualities forming the bulk of consumption; "and it is desirable that they should remain upon this good path," for, "if they were to attempt competition in the higher numbers with their brethren of England, who have brought their yarn to a pitch of fineness which we may almost term fabulous, it would, in our opinion, be a question rather of *amour propre* than of real utility." There was no evidence, at the period of my visit to the country, and interviews with some of the mill owners and importers, of a disregard of the advice thus given. Russia will, for a long time yet to come, adhere to the production of the ordinary numbers, and the fabrics woven from them, they being best suited to her domestic demand, and that of such countries in Asia as she supplies with either article.

With regard to the number of spindles in Russia at the time he wrote, the author says, that it had been common to assume one for each pood of raw cotton; but this he regarded as too low, citing the work of M. Samoiloff, on the "Spinneries of the Government of Moscow," of which there were, in 1843, twenty-two, reckoning 155,404 spindles, and yearly producing 155,949 poods of yarn, none of which was finer than Nos. 38, 42; which gave an average of $40\frac{14}{100}$ pounds per spindle; in making up his own estimate, he assumes the proper average to be 45 pounds per spindle, and making his calculation upon the importation of 1,329,031 poods of raw cotton, and the production of 1,129,000 poods of yarn, during the triennial period of 1848–'50, he arrives at the number 1,004,000, which, together with 50,000 then in operation in the kingdom of Poland, and those in the spinning mills of the grand duchy of Finland, he concludes that the total number may be set down at 1,100,000 spindles. The justness of this conclusion he strengthens by comparisons with the estimated number of spindles and the production of yarn in England, France, and several other countries, and assigns to Russia the fifth place in spinning industry among those nations where it "had attained to a certain degree of importance." The order in which he named those nations was: England, France, the United States, Austria, Russia, the Zollverein States, Switzerland, Belgium, Italy, and Spain.

On this subject of cotton-spinning, later information, as to the number of mills and spindles, will be found in the communication, hereafter alluded to, of M. Boutowen.

In the department of weaving, Prince Tégoborski observes, that the 1,371,196 poods (51,363,056 pounds) of cotton fabrics manufactured

in Russia, according to the average importation of raw cotton and twist, during the triennium of 1848–'50, represent, at the rate of 40 roubles ($30) per pood, a value of 54,847,840 roubles ($41,136,880.) In Poland, he places the manufacture, according to information which he regards as more reliable than official returns, at 500,000 poods, all of which, being very common calicoes and stuffs, he estimates as worth only 25 roubles ($18 75) the pood, or $937,500, making a total of 56,000,000 roubles, (or $42,000,000,) from which the following deductions are drawn:

	Rix Dollars.
1. About 1,400,000 poods (50,400,000 pounds) of raw cotton, including importations into Poland at 6 Rix dollars ($4 50) per pood	8,400,000
2. About 300,000 poods (10,800,000 pounds) of yarn, including importations into Poland, in round numbers,	5,000,000
3. For at least 1,000,000 poods (36,000,000 pounds) of cotton prints, the value of the tinctorial and chemical substances used, at 5 Rix dollars ($3 75) per pood	5,000,000
4. About 4 per cent. on the total value of the manufacture, to represent interest of capital employed in the acquisition of machinery imported, in round numbers	2,000,000
Total	20,400,000

He arrives at the conclusion that the addition made annually by this branch of industry to the national wealth is equal to R. D. 35,600,000 ($26,700,000.) In a note it is stated that in 1852 the importations of raw cotton and twist gave 1,599,000 poods, (59,564,000 pounds,) representing a value of R. D. 63,960,000 ($47,960,000.)

As to the number of persons employed in cotton manufacture, only approximative estimates could be made.

The 22 spinning mills in the Government of Moscow, in 1843, with their 155,404 spindles, employed 8,348 hands, or 19 spindles to each hand; assuming 20 spindles as a fair average to each person employed, and with an assumed total of spindles of 1,100,000, the result would be 55,000 persons in that branch.

At that period there were in the same Government 382 other establishments for weaving, bleaching, dyeing, &c., employing altogether about 42,500 operatives, and producing fabrics to the value of 12,500,000 roubles, ($9,475,000,) being an average of 294 roubles ($211 50) per operative. With this proportion there would be required for a production of 56,000,000 roubles, ($42,050,000,) 190,000 operatives; but, as in that calculation, the weavers working outside the mills in the villages, &c., were not included, 200,000 was assumed as the true number of employés in all departments.

Regarding the annual consumption, *per capita*, of cotton manufactures, it is said: "In Russia, the average quantity manufactured during the period of 1848–'50, amounted, as has been already seen, to 1,361,196 poods (49,363,056 pounds;) adding the quantity manufactured in the kingdom of Poland, (about 50,000 poods,) we may

estimate the total quantity manufactured in the country at 1,420,000 poods (51,120,000 pounds.) The average value of the importation, during the same period, was 3,857,000 roubles—equivalent, at the rate of 60 roubles per pood, to 64,283 poods. The average exportation to Asia represented a value of 2,370,000 roubles—equivalent, at the rate of 40 roubles per pood, to 59,265 poods; so that the importation and the exportation nearly balanced each other. There remained, therefore, for home consumption, 1,420,000 poods, which, distributed over a population of 65,500,000, gives 0.87 pounds, Russian, per inhabitant. The value of the home manufacture being 56,000,000, and the excess of the importations 1,487,000 roubles, the total value of the consumption is 57,487,000 roubles, or 88 kopecks (100 to the rouble) per inhabitant."

That this proportion has considerably augmented during the past seven years, notwithstanding the war with the Western Powers, there can be no doubt; and in this respect Russia approaches nearer to other Continental European nations than she then did.

The fabrics mostly produced are of a common description, as calicoes, plain cottons, nankins, &c.; the finer fabrics, as muslins, jaconets, fine handkerchiefs, plushes, &c., requiring nicer apparatus and more skillful hands. The former class are woven throughout the villages and country; the latter only in establishments especially constructed for the purpose. The peasants employed themselves weaving only in the intervals of their ordinary labors, and were therefore content with moderate wages; for a piece of 54 arschines in length by 1 in breadth, (somewhat more than three-quarters of a yard,) the price paid was seldom higher than 2 paper or 1 silver rouble (silver rouble equal to 75 cents.) At Moscow, and for better weaving, 2 silver roubles were sometimes paid per square arschine; further eastward, in the Government of Wladimir, not more than 3 paper kopecks, or $\frac{6}{7}$ kopeck silver, for the square arschine, were allowed for weaving, and considerable speculation is carried on to secure the profits by a class of small capitalists, who act as middle men between the substantial capitalists and the weavers.

Mr. Scherer, an authority on this subject, had arranged the cotton fabrics produced in Russia into three classes:

1. Common calicoes, at the average price of 6 kopecs silver per arschine.
2. Medium calicoes, at the average price of $7\frac{1}{2}$ kopecs silver per arschine.
3. Finer calicoes, at the medium price of $8\frac{2}{3}$ kopecks silver per arschine, the length of the piece being from 32 to 54 arschines, and the breadth $\frac{4}{4}$, $\frac{5}{4}$, $\frac{6}{4}$, and $\frac{7}{4}$ arschine.

"Of all branches of the cotton manufacture," observes Prince Tégoborski, "this, in our opinion, is the most important and the most advantageous for the country. It is exercised on an article of consumption accessible to the numerous classes, and it increases the means of our rural population, without interfering with their family habits."

Power-loom weaving had been introduced into Russia previous to

1850, the great obstacle to its extension being found in the cost of the machines; the principal seat of the manufacture was at Moscow, though it was also practised at St. Petersburg, and at other points of the empire. Velveteens, destined for the Asiatic markets, were also manufactured to a considerable extent, from 1,800,000 to 2,000,000 arschines, being annually sent into China, and during the English war with that power, 3,000,000 arschines. Bobbinet machines had also been put into operation at St. Petersburg, being the invention of Haymann, of Mulhouse, in France.

In 1843, M. Scherer reckoned that there were 140 weaving establishments in the country, besides the innumerable looms to be found in the villages and their vicinities, and the number of both was continually increasing, while the native weavers were advancing in skill and the neatness of their work. Printing had been introduced as far back as 1828, and numbers of Swiss and Germans had engaged in it, carrying on a growing and lucrative business. There is much of this work now carried on in the government of Wladimir, the articles produced being generally destined for the cheapest markets, while those of a dearer class are principally printed at St. Petersburg. At Moscow, both the common and the finer fabrics are printed, and, according to M. Samoiloff, that Government contained, in 1843, three hundred and eighty-two weaving and printing establishments, of which the annual products amounted to 12,417,000 roubles ($9,312,750;) of these, the city of Moscow and its environs possessed 176, producing to the value of 8,202,000 roubles. Next after the Government of Moscow, in this respect, ranked that of Wladimir, and afterwards that of Kostroma, which together produced as much as Moscow, the three producing five-eighths of the entire value of the cotton industry of the empire, in 1843.

The latest improvements in machinery had been introduced, and the Russian printers were able to compete successfully, as to the style of their work, with the best establishments of France, Germany, or Bohemia.

Although, in several portions of his great and most valuable work Prince Tégoborski manifested a decided leaning to the theory of protection to domestic manufactures, his mind was too clear and his judgment too impartial to permit him to close his eyes to the injury which a too thorough devotion to it might inflict, not only on the progress of art in manufacture, but upon the interests of the great mass of consumers; thus he says: "Though it is unquestionable that the prohibitory system has given a great impulse to our manufactures, it has also been attended with its own disadvantages. One of the chief of these, setting out of view the sacrifices imposed on the consumer, has been the moral influence which the system has exerted on the manufacturers themselves. Sheltered from the competition of foreign industry, they have remained absolute masters of the home market, and been able to fix their own prices. Freed from the care of seeking foreign outlets, for, with the increasing demands for consumption, there was no fear of a want of customers, they turned their

eyes incessantly to the tariff, which became the main regulator of their calculations. In this comfortable position, it required only some capital, a little intelligence, and less trouble, to enable them to realize, in a short time, large profits; and this was just what spoiled them." * * * * * "In our opinion, the time has arrived when a little more competition from abroad has become requisite, were it only to stimulate the activity and intelligence of our home manufacturers, and to give them that confidence in their own strength which they will never acquire by continuing to lean upon the crutch of custom-house prohibition."

This interesting and instructive review of the cotton manufacture of Russia, as it existed previous to, and in the year 1853, contains this brief summary of the results of the able author's reflections:

1. "That the cotton manufacture, occupying as it does in the total value of its products the next place to the linen manufacture, has attained with us a high degree of importance, and contains the elements of a large development.

2. "That we possess in the different branches of this industry many first class establishments, which may take rank alongside of the principal factories of the Continent, or even of England; and that several of these leave almost nothing to be desired in regard to their technical and mechanical organization.

3. "That, nevertheless, taken as a whole, this manufacture is, with us, greatly behind what it is in other countries, and especially in England, and that the defects which we have already pointed out are manifested principally at the two extremities of the scale, namely, the manufacture of common calicoes and of very fine fabrics; but these faults are gradually disappearing, and in certain departments the progress made of late has been conspicuous.

4. "That if our manufacturers adhere to the right path—that is, if, instead of struggling to produce articles of luxury and of great fineness, requiring highly complicated machinery and highly skilled operatives, they confine their attention to the improvement of those branches which are most appropriate to the *ensemble* of our material and intellectual resources—we may, for all articles destined to supply the lower and middle classes, soon attain the Continental level."

With a population in Europe of 65,500,000, but a small proportion of which rises to what is understood by the phrase "middle classes," and the great mass of which is of the lower class, together with the demand from the Asiatic portion of the empire and the nations which are their customers, Russian manufacturers have here certainly laid before them a most inviting future, and one which should encourage them to both activity and enterprise.

In conclusion, the following recapitulatory table of the four principal branches of Russian manufactures is presented:

CLASS OF GOODS.	Gross value of manufactures.	Addition to national wealth after deducting cost of raw material.
	Silver roubles.	*Silver roubles.*
Linen and hemp	112,000,000	75,500,000
Woolen	46,000,000	29,500,000
Silk	15,000,000	7,500,000
Cotton	56,000,000	35,000,000
Total	229,000,000	148,500,000

The number of individuals employed in these different manufactures, either constantly or a portion of the year, including all who are employed in the handling of the raw material or in the production of articles outside the manufacture, is stated at, for

Linen and hemp	4,500,000
Woolen	300,000
Silk	40,000
Cotton	260,000
Total	5,100,000

Under the heading of "Foreign Commerce," the same author gives statements of the trade of Russia with other nations, at the period of writing. The exports of cotton manufactures as shown by a table exhibiting the mean annual exportation since 1824, are given in periods of five years. The Russian values are, for the sake of convenience, reduced, in this table, as in those which follow, to our own. During the five years ending with 1853

1828	$589,725
1833	966,300
1838	904,500
1843	1,269,000
1848	1,615,275
1853	1,959,525

Note.—In a note to this table it is stated that a change in the official valuation of the articles sold to the Chinese had taken place, so that the *real* augmentation in value of the exportations of cotton manufactures had been since that date as follows :

1842 — 1844	$1,533,825
1845 — 1847	1,652,550
1848 — 1850	2,027,100
1851 — 1853	1,963,425

The market was Asia, as, in the whole period of 30 years, the exports to European countries had summed up to only $387,000.

The exportation to Asia was thus distributed:

China	$1,048,500,	or 53.6	per cent.
Steppes of the Kirghiz	605,700,	or 31.0	"
Tushkend	149,400,	or 7.6	"
Bokhara	106,800,	or 5.5	"
Khiva	22,275,	or 1.1	"
Persia, Asiatic Turkey, and Khokan	23,850,	or 1.2	"
Total	$1,956,675,	100.0	

The exports to China consisted chiefly of cotton velvets and a species of nankins; to the other countries mostly of cotton prints.

In the year 1853, Russia imported from England raw cotton to the value of $5,444,850; cotton twist to the value of $997,025; cotton manufactures to the value of $328,575. In exchange, she sent, among other merchandise, grain to the value of $8,140,725; tallow of the value of $6,119,925; flax to the value of $6,042,375; &c., &c., making a total of $36,995,950, against an importation of a total value of $19,772,500. Raw cotton, nine-tenths of which was of the growth of the United States, constituted 28⅗ per cent. of all that England sent to Russia. In the same year, Russia received from the United States raw cotton to the value of $1,487,700, (being sixty-eight hundredths of total import,) of the value of $2,187,350. In return, she sent us a total value of $1,672,875, consisting of sail-cloth and coarse linen, linen and hempen yarn, iron, cordage, hemp, bristles, feathers, &c.

The direct trade in raw cotton between the United States and Russia is, however, on the increase, she having received directly from our ports, in 1856, an amount of 124,000 bales, which, at the rather low average of 450 pounds to the bale, would make a total of 55,800,000 pounds.

The communication of M. Boutowen, the president of the council of manufactures and commerce, at Moscow, kindly forwarded to me since I left Russia, will show what are the chief obstacles to the further increase of direct importation. It may here be said, in passing, that they consist, mainly, of the absence of financial facilities, and of the alleged defects in the classification and sorting of cotton in American markets.

Answers to the questions relative to the cotton industry in Russia.

Question 1. In Russia there are, at this time, (November, 1857,) about 55 cotton spinneries, with a total of 1,200,000 spindles, and employing near 60,000 hands. Weaving, dyeing, and printing cotton stuffs, occupy four times that number of people.

The principal spinneries are found in the Governments of St. Peters-

burg, Twer, Moscow, and Wladimir. Moscow and Wladimir are the central points for the fabrication of cotton stuffs, but a large quantity of them is also produced in the small manufacturing establishments scattered through the country in the Governments of Kalouga, Taroslaw, and Riazan.

The expenses for weaving vary greatly, according to the nature of the work by the task or by the day. The day's wages of an adult man are of an average of 40 to 50 silver kopecks. We estimate at about 2 silver roubles the cost of the labor on a pood of yarn, Nos. 38 to 40.

Question 2. In 1853, the Russian factories consumed 1,938,000 poods of raw cotton; of this quantity 1,814,282 poods were of American growth, imported almost exclusively by way of Cronstadt, and of which 475,000 poods were of direct importation ; the remainder, or at least the greater portion of it, was from the ports of Great Britain. About 124,000 poods were imported from Persia, by way of the Caspian Sea, or by the land route, on the backs of camels, from Khiva, Bokhara, Tushkend, and other countries of Central Asia, by way of Oldenbourg. An insignificant quantity was also imported from the Levant, by way of the Black Sea.

The prices of American raw cotton, according to the quotations in the market of St. Petersburg, were, in 1853, from 5 to 7 roubles 50 copecks the pood. At Moscow, they were as high as 8 roubles 50 copecks. At that time, Asiatic cotton was selling at Moscow at 4 roubles 50 copecks. At this time, in 1857, the prices have risen at Moscow, for American cotton, to 9 and 10 roubles, and for Asiatic to 5 roubles 75 copecks, 6 roubles 75 copecks, and even 7 roubles. Hereafter, when the railroad between Moscow and Libau is finished, the importation of cotton through the latter place will become more advantageous than through Cronstadt. The Asiatic cottons are used only for the lower numbers of yarns, and cannot compete with American for medium and fine numbers.

Question 3. Under the tariff of 1857, raw cotton coming into Russia by way of the European frontier pays a duty of 25 copecks the pood ; that which comes from Asia pays 5 per cent. upon the declared value. White cotton yarn is taxed at the rate of 3 roubles 50 copecks the pood ; and so also is candle-wick. Dyed yarns of all colors are taxed 5 roubles the pood. The duties are still very high, and do not in any respect stop the growth of national spinning. In 1856, before the last custom-house reform, the duty on white yarn was 5 roubles the pood. Under the new tariff, large mills have been undertaken and are about to be put into operation at Vishnee, Volotchok, and in the vicinity of Narva. These establishments are not included in the estimate above given, in answer to question No. 1.

Question 4. The spinning mills of the country produce yearly near 1,400,000 poods of yarn, of the value of 21,000,000 silver roubles, the whole of which is consumed by the domestic manufacturers.

Question 5. But little sewing thread is fabricated in Russia, the greater part of that description of spun yarn being imported, as well as of the yarns above the Nos. 40, 42. In the year 1852, the

importation of these two articles combined, by way of the European frontier, was 80,000 poods, of the value of near 1,000,000 silver roubles. Besides, hand-spun yarn was imported from Asia to the amount of 17,436 poods, and value of 143,000 silver roubles; they are used only for the fabrication of the coarsest cloths.

Question 6. From the quantity of spun cotton, both domestic and imported into Russia, the quantity of cotton stuffs therein manufactured annually is not less than 1,400,000 poods, of which 400,000 are sent into market bleached, and the remainder dyed or printed. The tissues principally fabricated are calicoes, mitrales, percales, nankins, ordinary indiennes, neck-handkerchiefs for peasant women, and shirtings for peasant men, persiennes for furniture, and, in general, those articles for which the yarns used vary between the lowest numbers and numbers 38–40. The fabrication of fine and elegant tissues, such as jaconets and muslins, is yet very restricted in extent.

Question 7. The value of cotton tissues, of all descriptions, fabricated in Russia, may be estimated at about 65,000,000 silver roubles. Nearly all of it is consumed within the country. Russia exports cotton stuffs only to Asia, their value not exceeding 2,500,000 silver roubles.

Question 8. Several establishments fabricate mixed tissues of cotton and wool, such as mousselines de laine, covers for furniture, half cashmeres, cassinets, lastings, &c. It is impossible to estimate, even approximatively, the value of the relative quantity of the cotton which enters into these fabrics. Besides which, it is included in the preceding estimate of the value of yarn consumed in Russia.

Questions 9 and 10. There is no direct exchange between Russia and America; nor are there, moreover, between the two countries, direct commercial relations between merchant and merchant. Some Russians have ordered cotton directly from America; but it was through the intervention of English merchants, who undertook the operation for a commission of *one per cent.*

To purchase raw cotton, without an intermediary at New Orleans, or some other American port, it would be necessary for the Russian manufacturer to send thither an agent, with specie, or drafts bought in Europe. In the actual condition of things, it is much more convenient for him to buy his cotton from English merchants at London or Liverpool, who grant credits more or less extended, at 5 per cent. per annum; besides which, in England, and particularly at Liverpool, where cotton is sold, after having been sorted, and under guaranty, while in America, cotton is put upon the market without being sorted and without guaranty.

It is to be observed that the prices of cotton acquire commercial stability only in the English market; consequently, a Russian speculator, who should go to buy raw cotton in America, even at the period of the crop being gathered, which is the most advantageous for the purchasers, would run the risk of paying for it more than the current price two or three months later. All these causes combined induce the Russian spinner to prefer the English market to the direct purchase of the cotton in America.

Exchange on London is, on three months' bills, from 37 to 38, and even 39 pence the silver rouble. At this date, (November, 1857,) it has fallen to 34.

Question 11. The United States being themselves producers of the principal articles of Russian export, it is difficult to answer this inquiry. However, it is plain that if the Americans could find it to their advantage to import from Russia, in exchange for their raw cotton, her cloths, of medium qualities, worth from 80 copecks to 2 silver roubles the arschine, with a breadth of 2 arschines, which are very good, as well as those stuffs called Flanders linens, and sail-cloths, which are already well known on the other side of the Atlantic, it is not to be doubted that it would lead to a more active commercial exchange, and facilitate the establishment of an interchange of products and direct trade between the two countries.

Question 12. Raw cotton, in transit through Russia, for the kingdom of Poland, pays a light transit duty of about 10 copecks the pood. Cotton brought by sea into the empire does not, since the abolition of the Sound dues, pay any transit duty.

Question 13. The best American cotton suffers a waste of near 15 per cent. For a pood of yarn, No. 38, 1 pood and 7 pounds of raw cotton are required.

The Asiatic cotton is much less pure than American, and shows a greater waste.

A. BOUTOWEN,
Counsellor of State, President of the Section of the Council of Manufactures and Commerce, at Moscow.

An English gentleman, long resident at St. Petersburg, and interested in two or more of the mills in the vicinity, furnished me with a memorandum of the amount of raw cotton received at that port up to the 1st of August of the last two years.

In 1856, the amount was 1,343,038 poods (48,349,368 pounds;) and in 1857, it was 1,645,606 poods (59,241,816 pounds.) This gentleman owns shares in the "Russian" cotton mill, the capital of which is 1,000,000 roubles, ($750,000,) in shares of 1,000 roubles, with 65,000 spindles, employing 900 hands, and yearly consuming 6,500 bales of cotton; and the new mill, with a capital stock of 800,000 roubles, ($600,000,) also in shares of 1,000 roubles, with 55,000 spindles; it employs 1,300 hands, and consumes annually 10,000 bales of cotton, being last summer, and perhaps still, worked day and night. The Russian mill produced yarns Nos. 20 to 40; the new mill Nos. 30 to 40, all for warp. Its spinning machinery was the English self-acting mules. A spinner, having charge of two mules, could clear 25 roubles ($19) per month. Ordinary workers got from 7 roubles ($5 25) to 9 roubles ($6 85) per month. The proportion of females to males employed was as 600 to 1,000. The raw material cost, on the average, delivered at the factories, $8\frac{1}{2}$ roubles ($6 38) the pood, or about $17\frac{7}{10}$ cents per pound, and the description of cotton was from middling to good middling.

During the last eighteen months, the price of cotton yarn had ranged

between 16 roubles and 22 roubles the pood (from \$12 to \$16 50) per 36 pounds weight (from $33\frac{3}{10}$ to $45\frac{8}{10}$ cents) per pound. The production to the spinner he believed to be, under the new tariff, about $3\frac{1}{4}$ roubles net, the pood. or rather more than 3 pence per pound (near 6 cents.)

Notwithstanding the largely increased domestic production, a considerable quantity of English yarns was still imported, there having been received at the custom-house in St. Petersburg, up to the 1st of August last, 81,570 poods (2,936,520 pounds) against 17,853 poods (642,708 pounds) up to the same period of the previous year.

The importation of dyed yarns had been, respectively, 1,032 poods, (37,152 pounds,) in 1857, and 392 poods, (14,112 pounds,) in 1856; of cotton fabrics and tissues, 10,852 poods, (390,672 pounds,) in 1857, and 2,079 poods, (74,694 pounds,) in 1856.

My informant believed that, under the new tariff lately enforced, the importation of dyed yarn and of cotton fabrics and tissues would increase.

The business of spinning had been more profitable than ever during the years 1856–'57, and hence the activity in all the mills, most of which had been working day and night, large additions having been already made to the number of spindles, and still others being contemplated, besides the erection of new establishments on a grander scale than had been hitherto known. Whether the business was to continue as prosperous as it has of late been, he considered doubtful, as there might be both too great a production of yarn and too great competition among the spinners.

Upon the question of the supply of fuel at reasonable rates, one of first importance to the Russian manufacturer, where all the establishments are worked by steam, this gentleman informed me that the import of English coal up to the 1st of August, 1857, had been 49,005 chaldrons, against 25,464 up to the same period in 1856. The facilities for importation were better now than they had formerly been, and its employment would increase. He said that, although 10 roubles' worth of wood made as much heat as the same amount of coal, the latter was preferred.

I was fortunate in procuring a letter of introduction to Mr. Robert Craig, the chief manager of the Newsky mill, in St. Petersburg, and am indebted to him for his very kind reception, and the readiness and intelligence with which he explained the nature and extent of the spinning operations at and near the capital, and the details of his own establishment, which is regarded by all as a model one. At the time of my visit, the Newsky mill was running 60,000 spindles, which were soon to be increased to 140,000. Its annual consumption was 6,000 bales, of about 420 pounds each, all of which, with the exception of a very small quantity of Brazilian, was of the growth of the United States, and was spun into yarns, ranging from No. 30 to 40, the great bulk of which was sent to be disposed of in the Moscow market. The entire supply of the raw cotton used was purchased in Liverpool, and complaint was made that it had, during the preceding year, contained more sand and dirt than usual; there had been, how-

ever, but little wastage, as the high prices to which the article had risen compelled the spinners to work it all up.

The policy of purchasing in the Liverpool market, instead of at New Orleans, Mobile, or Charleston, was explained to be on account of the more reliable classification or sorting at Liverpool than in the United States. The duty of 25 copecks ($\frac{1}{4}$ of a rouble, or 18$\frac{3}{4}$ cents) per pood, he considered as merely nominal, and not calculated at all to affect consumption. The mill annually produced about 62,000 poods, (2,232,000 pounds,) or, by spindle, one pood each of yarns, which, at an average of 18$\frac{3}{4}$ roubles the pood, were worth 1,162,500 roubles ($871,875.) At that time, the market was good and rising. Mr. Craig regarded the protection under the tariff, to the spinner, as equal to about 5$\frac{1}{2}$ pence per pound on the yarns spun. The mill employed 700 hands, nearly all of whom were boys, women, and girls; men not being liked, nor as readily to be had. The wages paid to this working force for 24 working days in a month, were 8,000 roubles, ($6,000,) they finding themselves. The operatives whom I saw, during their dinner hour, were healthy and cheerful in appearance, and I was told by Mr. Craig that they were always contented, and a much better class of people than they had sometimes been represented.

With regard to the future consumption of raw cotton in the country, he regarded the prospect for its increase as very good, and on this point, expressed some solicitude as to the capacities of our cotton-growing States to keep up with the increasing demand throughout the civilized world for that raw material, as he felt satisfied that to the United States must the world look as the only certain and reliable source of supply for the great bulk of the demand. I felt authorized to reply that, if left to themselves, and paid remunerative prices, our planters could largely increase their production, so that its amount in the total production of the world would be proportionably much greater even than it now was. In his remarks on this point, he showed a correct appreciation of the position and advantages of our cotton growers, as contrasted with those of other countries.

At the establishment of Messrs. Thomas Wright & Co., near St. Petersburg, I was cordially received by the chief manager, also an Englishman, and my questions cheerfully answered.

This mill has 85,000 spindles, employs 700 hands, nearly all boys, women, or girls, whose wages range from 10 to 20 roubles per month, and consumes annually about 70,000 poods of raw cotton, (2,500,000 pounds,) and turns out nearly the same weight of cotton yarn, No. 40. The cotton used is New Orleans, Upland, and Boweds, mostly of middling quality, and its average cost, on reaching the mill, is 8$\frac{1}{4}$ roubles ($6 19) to 8$\frac{1}{2}$ roubles ($6 38) per pood. The waste did not exceed 5 per cent.; supplies purchased in England. The price of the yarns spun varied from 13 roubles ($9 75) to 21 roubles ($15 75) per pood, according to the demand.

There are several other mills at or near the capital; among them the Imperial Factory, belonging to the Government at Alexandrovsky, with a force of 55,000 spindles. It was said not to pay any profit on its operations. Nearly all these various establishments had lately

made considerable additions to their number of spindles, or were about to do so. The quality of cotton consumed, that of the yarns spun, the rates of wages paid, &c., were, I was told, quite uniform. The machinery is generally of the very best English manufacture, embracing all the most recent improvements on inventions. The same thing may be said of the mills at or near Moscow.

The largest cotton importing house in Russia is that of Messrs. J. H. Frierichs & Co., of St. Petersburg, the resident partner being Mr. Marsh, to whom I am indebted for acts of courtesy and valuable information as to the state of the demand for cotton, present and prospective, &c., &c.

The extent of the business affairs of this house, in Russia, may be judged of by the fact, that of 2,000,000 poods of cotton imported into Russia, in 1856, 850,000 poods passed through its hands. From Mr. Marsh, I learned that the importations were almost exclusively of American growth, Surats being never used, except when mixed with the better and longer stapled American cottons, a process not yet understood by the native spinners. The firm had tried the experiment of importing two cargoes of Surats, but had concluded to order them to Liverpool for sale, finding they did not suit the Russian market.

Mr. Marsh considers that the Russian practice of buying in the Liverpool market is, in no small degree, caused by the fact that the managers of the mills, who are all English, are unwilling to receive stocks purchased elsewhere, believing that in England alone the proper classifications for the descriptions of yarn in demand in the Russian market are to be had, and their influence prevails over other considerations with the owners.

In August last, as Mr. Marsh told me, all the customers of his house had obtained their supply of raw cotton up to the summer, and several even until the month of October, 1858. At the same time, he estimated the stock of cotton then on sale, at St. Petersburg, at 25,000 bales. The house of J. H. Frierichs & Co., which, in addition to its Russian business, has a large custom in Germany, had of late decided to change its former system of ordering its purchases of raw cotton in the United States to Liverpool, and hereafter to send them to Grimsly. on the east coast of England, whence they might be more convenient and rapidly distributed to the ports of the North Sea and the Baltic.

As to the prospect of cotton-spinning in Russia, he regarded it as quite good, although it was not unlikely that some who were engaged in it, without ever having had the necessary capital, would have to succumb under increasing competition and high prices.

It is a source of much regret to me that the statement, promised by Mr. Marsh, of the importation of raw cotton, yarns, fabrics, and tissues of all descriptions into Russia, with the average prices, and a list of the mills, the number of spindles, looms, &c., for the last four years, has not yet come to hand.

The Russian cotton manufacturer, while subject to disadvantages caused by remoteness from the ports of the country which grows not less than nine-tenths of the raw material that he needs, from his dependence for those supplies on the intermediate market of England,

whereby he has to pay an enhanced price, which varies according to the abundance of money, the activity of speculative demand, or of the manufacturing interest in that country, to say nothing of the long array of brokers' and factors' commissions, charges for handling, warehousing, sorting, bankers' profits on several sets of bills of exchange, affecting the raw material, and the difficulty attending the navigation of the Baltic, with its strong currents and interruption of navigation for more than half the year, has, nevertheless, advantages which insure him such profits, ordinarily, as to make him content with his position. He has abundant and cheap labor at his command, suffers no solicitude as to strikes or combinations among his operatives; and what is to him better than all, has a certain and profitable market for all articles produced by his capital and labor. There is but little prospect of this market failing for a long series of years to come, though the profits it now affords may be diminished to a point more nearly approaching the standard in other countries for similar industry.

The importance and expediency of direct trade between Russia and this country is fully recognized by her government and the more intelligent of her subjects. It is understood that the Emperor is desirous of the establishment of American houses at St. Petersburg and Odessa, in order that the experiment of direct commercial intercourse may be fairly tried.

The modifications made in the old tariff system by the tariff lately ordained. shows that liberal ideas, in that respect, influence the sovereign and his ministers.

The great system of railroads, projected to promote rapid and cheap communication between the shores of the Baltic and those of the Black Sea, and between the banks of the Neva and those of the Volga, will be prosecuted. Already, the branch of the line between St. Petersburg and Warsaw, which is directed on Libau, upon the Baltic, and almost touching the frontier of Russia, is being constructed with all practicable despatch, and, when finished, will have an immense influence on the commerce of the country with Western Europe and the United States, as ships will be able to go there and discharge their cargoes a month earlier than they can do it now; that they have to contend, not only with the heavy current coming from the Gulf of Bothnia, and the north winds which sweep down it, but also with the ice in the Gulf of Finland, which rarely breaks up much before the 1st of May, and closes it by the 1st of November.

The Russian government views the commerce by way of the Black Sea with great favor, and in the new tariff makes a discrimination in the rate of duty on cotton or cotton manufactures coming into the empire in that direction. Besides, being rarely frozen over in winter, the port of Odessa offers to ships carrying thither cargoes of cotton certain and profitable freights to Western Europe of grain, tallow, hides, or other articles of domestic growth, of which it is the great depôt.

Besides the gentlemen named above as having aided me in my inquiry, my particular thanks are due to Mr. Seymour, the minister,

and Mr. Pierce, the secretary of our legation at St. Petersburg, and to Mr. Claxton, consul at Moscow, all of whom exhibited much interest in the inquiry with which I was charged, and a desire to forward it to the extent of their power.

THE ZOLLVEREIN STATES.

The German States have consumed a portion of the cotton crop of the United States since a period shortly posterior to its introduction in any considerable quantities into the European markets ; and during the last decennial period, this consumption on their part of the raw material, whether of the growth of our own or other countries, has increased to such an extent as to command the serious attention of any one who takes a survey of the condition of cotton manufacture in Europe, and its influences on the industry, the trade, and the general well-being of those populations among whom it is carried on.

Eleven German sovereignties have united themselves with the free Hanseatic city of Frankfort-on-the-Main for the formation of the Zollverein, or Customs' Union, at the head of which stands the kingdom of Prussia, the most important in population and political position, and at whose capital the affairs of the Union are managed. In the year 1853, the total number of inhabitants of this commercial league was 30,687,939, which had increased, by the census taken in December, 1855, to the figure of 32,559,161, of which Prussia counted 17,286,284.

In the year 1847, the total import of raw cotton was 364,590 Zoll-centners, equivalent to 40,326,404 of our pounds. In 1853, it had increased to 810,439 centners, or 89,395,474 pounds, having much more than doubled in the period of thirteen years. It will be seen hereafter that, during the same period, a marked decrease in the importation of cotton yarns had taken place, which shows that the demand was becoming yearly less and less dependent for supply upon the foreign spinning mills.

In his *Statistical Review of the most Important Objects of the Trade and Consumption of the German Zollverein*, for the period from 1849 to 1853, published at Berlin last summer, Dr. C. F. W. Dieterici, director of the Statistical Bureau of Prussia, furnishes a series of illustrative tables which show the increasing importance of the cotton trade. As the work is regarded as of standard authority, the tables which accompany the report have, where credit is not given to other sources, been compiled from it.

Table *A* exhibits the total of the imports, exports, and transit of raw cotton into, from, or through each of the States of the Union during the year 1853. It will be seen that out of a total of 91,126,119 pounds imported, Prussia received 71,274,407 pounds. This was owing rather to her geographical position, and the facilities for transportation which it afforded, than to the extent of her manufacture,

as, in that respect, she is exceeded by Saxony, which appears to have taken for consumption much less of the raw material. But it is difficult to judge of the actual extent of consumption in any of the States of the Zollverein from these tables, for the reason that raw cotton being free of duty, there is no necessity for keeping an account of the real amount which goes into any one of the States composing it. In the year 1856, there were, according to Mr. George Von Viebahn, chief of division of the financial department of the ministry of commerce, &c., at Berlin, in the kingdom of Prussia, 88 spinneries, with an aggregate of 288,907 spindles, which, at an estimate of 40 pounds, each, of the raw material per annum, required only 11,556,280 pounds of it.

According to official publications, kindly furnished me by Mr. Von Viebahn, the importation of raw cotton into the Zollverein, during the year 1855, amounted to 936,406 centners, or 118,820,546 pounds ; and for the first quarter of 1857, to 238,323 centners, or 26,288,219 pounds.

With regard to the extent and condition of cotton manufacture, it may be said that its march, particularly during the past twenty years, has been, on the whole, steady and progressive, as within that period the extension of railroads into nearly every portion of the territory has afforded facilities which were before unknown for the speedy and cheap transportation of both the raw material and of articles fabricated from it; thus bringing into play the natural advantages for manufacturing possessed by many of the interior countries of Germany, but which, owing to difficulty of access, had before remained unused. In this way, an impetus has been given to manufacturing industry in Bavaria, Wirtemberg, and the upper portions of the Grand Duchy of Baden, which promises, at no distant day, very important results.

Cotton-spinning by machinery has been known in Saxony for nearly forty years ; but neither there, nor in any other of the States composing the Zollverein, does it appear to have made any very marked progress until the year 1836, which is spoken of by all who speak or write on the subject, in Germany, as one fraught with interest in its history, as it was the era of the establishment in Bavaria and elsewhere of several extensive establishments modelled on those of England, and on a scale hitherto unknown, which, having met with abundant success in their operations, gave encouragement to others to embark their surplus capital in similar enterprises. Labor being abundant and cheap, and supplies of the raw material readily obtainable, the German spinners have been able, by a system of judicious management, and by studying the wants of their home markets, to place themselves on a firm footing. And the manufacturer of the present day, although subject to suffering from occasional fluctuations from financial crises in the commercial world, on the whole, holds a position which is quite satisfactory.

Dr. Engel, the distinguished statistician of Dresden, in his *History of Cotton-Spinning in Saxony*, lately published, speaking of the condition and extent of those establishments in the Zollverein devoted to it, remarks: "The Zollverein, in 1855, contained 1,200,000 spindles, consuming 63,600,000 pounds of raw cotton, and producing yearly

50,880,000 pounds of yarn, with a waste of 20 per cent. on the raw material; the annual yield per spindle being $42\frac{2}{5}$ pounds, which appears higher than the yield in England, but the difference is explained by the average number of English yarns being much higher.'' And again: ''A comparison of these figures with the English is very encouraging to the enterprising spirit of the German mill owners. The supply thus furnished is equal to $1\frac{56}{100}$ pounds to each inhabitant. Estimating the actual consumption at only 3 pounds per inhabitant, and supposing the supply to be altogether of domestic spinning, the amount of yarn produced would be 47,000,000 pounds more than is above stated, which would require an addition of from 1,000,000 to 1,500,000 of spindles.''

Since the year 1836, there have been established very extensive spinning mills at Augsburg, Kempten, and Immenstadt, in Bavaria; Urach, in Wirtemberg; Arlen, Ettlingen, and other points in Baden; and at various places in Rhenish Prussia, Rhenish Bavaria, and Silesia.

According to Dr. Engel, the leading causes which have favored the development of cotton-spinning are the magnificent water power found in the highland districts of some of the States, the encouragement afforded by government, and the success of the establishments on a large scale, and in imitation of the English system. The German spinners have not attempted, so far, competition with England or other countries in fine spinning, avoiding thus both the increased expense of fitting their mills with the necessary machinery, and the additional cost of working up the raw material.

By adhering to the plan of spinning the lower numbers only, the average, in 1855, being No. 23, they have obtained almost the entire supply of the home market. The duties being specific, (by weight,) instead of *ad valorem*, they would labor under great disadvantages in a struggle with a country so advanced in the art of cotton-spinning as England, as the duties by weight in fine yarns, although greater nominally, are really much less than those on the coarser and heavier qualities; hence, a considerable import of the finer numbers of yarns is still kept up, while that of the lower ones is quite limited, they having been appropriated by the domestic spinners, who have also, as Dr. Engel thinks, a fine prospect for spinning hereafter, with profit, the finer ones also.

Table *B* presents a statement of the imports, exports, and transits of unbleached, single or double-twisted cotton yarn into, from, or through the States of the Zollverein during the years 1851–'53; and that marked *C* shows also the import, export, and transit of unbleached yarns, treble-twisted or over, during the same period.

Of the first named-descriptions, the imports were as follows: 1851, 53,659,839 pounds; 1852, 51,209,322 pounds; 1853, 52,517,991 pounds. The exports were, in 1851, 1,498,379 pounds; in 1852, 1,461,210 pounds; in 1853, 1,500,034 pounds. The transits were, in 1851, 8,106,512 pounds; in 1852, 10,493,931 pounds; and in 1853, 9,634,529 pounds.

Of unbleached, treble-twisted yarns, the imports were, in 1851,

336,661 pounds; in 1852, 354,977 pounds; and in 1853, 336,267 pounds. The exports were, in 1851, 1,938,410 pounds; in 1852, 2,212,054 pounds; and in 1853, 2,740,949 pounds.

The transits were, in 1851, 1,311,848 pounds; in 1852, 1,178,836 pounds; and in 1853, 1,086,062 pounds. The official documents above spoken of, as furnished by Mr. Von Viebahn, show an importation of unbleached, single and double-twisted yarns, in 1855, of 492,186 centners, or 54,290,576 pounds; and in 1856, of 493,490 centners, or 54,434,413 pounds; and of unbleached, treble-twisted yarns, an import, in 1855, of 2,453 centners, or 270,579 pounds; and in 1856, of 2,495 centners, or 275,211 pounds.

The values are not given in any of these tables, not being required at the custom-houses; but the "Germania," a politico-economical journal, published at Heidelberg, and regarded as reliable authority, places the value of the entire import of cotton yarn, in 1855, at the sum of 14,564,400 Thalers, which, at 69 cents each, is equal to $10,049,436; and in 1856, at 15,164,690 Thalers ($10,463,636.)

The duty on unbleached, single or double-twisted cotton yarn, is 3 Thalers ($2 07) the centner ($110\frac{355}{1000}$ pounds); and on unbleached, treble, or over-twisted yarn, it is 8 Thalers, or $5 22, the centner.

The transit duties are regulated according to the tariffs of the States through which the rivers, on which most of the carriage is accomplished, run. They vary somewhat, but are not onerous. Considerable time might be required to ascertain their precise nature and amount.

Of cotton tissues, hosiery, &c., the importation, in 1855, was 7,764 centners, or 856,408 pounds; and in 1856, it was 9,139 centners, or 1,008,078 pounds, upon which the duty was 50 Thalers, or $34 50, the centner.

In the kingdom of Prussia, in the year 1856, there were 88 spinning mills, running 288,907 spindles. In 1852, there were in the kingdom 71,267 looms, of which 2,500 were machine looms, and the remainder hand. They produced every description of ordinary to fine cotton, pure or mixed stuffs. The cotton manufacture of Prussia is for the most part carried on in her Rhenish Provinces, which were not visited by me, for want of time. Of late, that branch of industry has made progress in and around Berlin.

Saxony has hitherto been considered at the head of cotton manufacturing industry among the States of the Zollverein, though of late, Bavaria has begun to contest with her this supremacy. The work of Dr. Engel, quoted above, gives many details on the past progress and the present condition of the industry.

In 1857, the number of mills in the kingdom, according to a statement kindly furnished me by Dr. Christian A. Weinlig, chief of division, &c., in the ministry of finance, was 135, running 600,000 spindles. The consumption of raw cotton was about 30,000,000 pounds, of which 12,950,595 pounds were of the growth of the United States, almost all of which was imported *via* Bremen; and 11,432,463 pounds of the growth of the East Indies, imported *via* Hamburg.

On the American cotton, the waste averaged 18 per cent.; on the East Indian, 24 per cent.; making a general average waste of $20\frac{81}{100}$ per cent.

The actual production, of yarn of all numbers—the average being 23—was 19,308,160 pounds, of the total value of 5,470,645 Thalers. The prices of yarn are regulated by those current at the time in the English or Hamburg markets, adding 2 new groschen, or 4 cents, for duties, transportation, &c.

The domestic production of yarn is all consumed at home ; besides which, there is an additional demand for about 15,000,000 pounds of yarn and twist.

There are, it is said, but very few purchases of American cotton made by direct negotiation, intermediate agencies at Bremen or in England being used. This remark will apply also to most other parts of Germany.

In the year 1857, there were in Saxony 20,000 looms, of which 500 were machine, employed in weaving pure cotton tissues ; from 8,000 to 10,000 looms employed in weaving tissues of mixed cotton and linen ; and from 20,000 to 25,000 looms, of which 1,000 were machine, employed in weaving tissues of mixed cotton and wool ; and 3,000 stocking weaving looms, about 400 of which consumed pure cotton thread.

Mixed goods and tissues are the chief productions of Saxon manufactures, consisting mainly of half cotton and half linen clothing stuffs, carpets, table and furniture covers, lastings, &c. There are also fabrics of cotton, mixed with wool or silk, too various for particular mention. In 1855, according to Dr. Engel, the employés of the spinneries were :

Adult males	4,216
Adult females	4,717
Boys	1,487
Girls	940
Officers, &c	276

Total amount of wages and salaries paid, $906,800. Of these, the men received $36\frac{5}{100}$ per cent.; the women, $40\frac{84}{100}$ per cent.; the boys, $12\frac{71}{100}$ per cent.; the girls, $8\frac{4}{100}$ per cent.; and the officers, $2\frac{36}{100}$ per cent.

To the United States the exports consisted principally of hosiery, valued at 2,000,000 Thalers ; cotton and linen goods, valued at 1,000,000 Thalers ; woolen cloths, valued at 1,500,000 Thalers ; and oth-r woolen goods, valued at 500,000 Thalers.

Want of time prevented my visiting either Bavaria, Wirtemberg, or Baden, though each offered an interesting field of investigation.

Much might be done by a properly accredited agent of the government, who could remain long enough in the different States of the Zollverein to make the acquaintance of the leading spinners in doing away with their erroneous ideas as to the production and trade in cotton, and of the practicability of direct trade between those countries and our own. Their errors, in this respect, have been created

and fostered, for the most part, by parties who have profited largely as the intermediaries of an indirect commercial intercourse, and whose plain interest it is to keep up the existing system.

The operations of the merchants of Bremen have, indeed, done much to relieve the consumers of the interior from the additional price they have been paying for the raw material, in the shape of profits, commissions, and various other charges, to English factors, brokers, bankers, &c.; but there remains yet much to be done, which, once effected, cannot fail, in the end, to benefit greatly both the country of production and that of consumption.

At present, the average price of cotton delivered at the mills in Saxony is 70 pfennings for Surats, and 100 pfennings for American "middlings," after being cleaned. The two descriptions are generally mixed in the proportion of one-third Surat to two-thirds American. Of cotton yarn, the average price is 85 pfennings per pound. Six pfennings are equal to one cent of our currency.

A.

Statement of the import, export, and transit of cotton into and from each of the States of the Zollverein during the year 1853; *the weights reduced to the standard of the United States.*

STATES.	Import.	Export.	Transit.
	Pounds.	*Pounds.*	*Pounds.*
Prussia, with Luxemburg	9,494		
Bavaria	71,274,407		
Saxony	902,075	527,919	
Wirtemberg	15,239,739	14,084,221	5,969,250
Baden	27,025	171,966	3,202,254
Electoral Hesse	3,086,224	185,091	8,226,657
Duchy of Hesse	43,681		
Thuringia			
Brunswick	15,333		
Nassau	525,493		9,165
Frankfort-on-the-Main			
Add import by the post	2,648		
Total	91,126,119	20,943,323	19,660,894

B.

Statement of the imports, exports, and transit of unbleached single and double-twisted cotton yarn into, from, and through the States of the Zollverein during the years 1851, 1852, *and* 1853, *derived from official sources; weights reduced to the standard of the United States.*

STATES.	1851.			1852.			1853.		
	Imports.	Exports.	Transit.	Imports.	Exports.	Transit.	Imports.	Exports.	Transit.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Prussia	39,345,462	788,562	1,300,223	38,377,976	885,528	1,964,421	38,988,818	973,440	1,314,561
Luxemburg	29,892	552	----------	35,518	----------	----------	30,665	----------	----------
Bavaria	1,885,001	66,844	3,953,111	1,568,978	46,328	4,121,735	1,748,333	49,305	4,230,086
Saxony	7,417,449	552,517	3,653,193	6,787,619	480,158	4,273,867	7,224,316	396,657	4,060,216
Wirtemberg	946,086	29,347	23,936	749,854	11,799	70,485	710,413	26,473	17,429
Baden	667,348	55,814	169,431	625,735	35,411	33,643	841,846	23,274	12,127
Electoral Hesse	320,541	----------	331	192,482	----------	221	225,463	110	110
Duchy of Hesse	313,047	----------	----------	271,901	----------	----------	300,030	----------	----------
Thuringia	1,591,975	----------	----------	1,546,807	----------	----------	1,544,490	----------	----------
Brunswick	77,655	4,743	6,289	81,071	1,986	29,559	82,287	30,775	----------
Nassau	20,075	----------	----------	44,893	----------	----------	22,832	----------	----------
Frankfort-on-the-Main	1,037,308	----------	----------	936,488	----------	----------	798,498	----------	----------
Total	53,659,839	1,498,379	8,106,512	51,209,322	1,461,210	10,493,931	52,517,991	1,500,034	9,634,529

C.

Statement of unbleached cotton yarn, treble-twisted and above, imported, exported, and in transit to, from, and through the States of the Zollverein during the years 1851 *to* 1853, *also from official sources; with the weights reduced to those of the United States.*

STATES.	1851.			1852.			1853.		
	Imports.	Exports.	Transit.	Imports.	Exports.	Transit.	Imports.	Exports.	Transit.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Prussia	158,729	1,366,898	840,188	165,016	1,624,241	680,258	156,192	2,007,889	707,827
Luxemburg	1,324	----	----	2,095	----	----	2,977	110	--
Bavaria	12,353	85,707	289,992	11,581	98,391	314,369	11,250	32,208	187,408
Saxony	29,450	395,774	13,122	39,610	350,990	18,851	44,673	314,921	39,490
Wirtemberg	5,515	6,288	27,576	7,059	31,988	33,423	4,964	28,789	30,444
Baden	10,921	64,551	138,213	12,355	73,573	131,483	9,817	63,977	119,239
Electoral Hesse	2,757	2,096	----	7,507	2,757	----	7,498	8,935	----
Duchy of Hesse	9,937	----	----	7,831	----	----	10,698	----	----
Thuringia	6,731	----	----	2,316	----	----	5,911	----	----
Brunswick	5,513	17,096	2,757	4,964	30,114	452	2,647	14,120	1,654
Nassau	8,310	----	----	----	----	----	----	----	----
Frankfort-on-the-Main	90,119	----	----	94,642	----	----	79,640	----	----
Total	336,661	1,938,410	1,311,848	354,977	2,212,054	1,178,836	336,267	2,470,949	1,086,062

THE AUSTRIAN EMPIRE.

It was not in my power to obtain any information as to the date of the establishment of cotton-spinning and manufacture in Austria or any of its German Provinces. Of late years, they have, however increased very considerably, having shared the general prosperity of that branch of industry in Europe. The import of cotton for the year 1856, according to the official review of the imports and exports for that year, published at Vienna, in 1857, amounted to 768,197 Zollcentners, which, at $110\frac{355}{1000}$ United States pounds, each, would make 84,774,371 of our pounds; of this 758,895 Zollcentners, or 83,747,858 pounds, were for consumption, and 9,302 Zollcentners, or 1,026,503 pounds, were in transit.

The importation of 1856, compared with that of 1855, exhibited an increase of 140,936 Zollcentners (15,552,993 pounds.)

The value of the cotton consumed was, in Austrian convention, florins 23,760,070, equal, at $48\frac{1}{2}$ cents each, to the sum of $10,938,634.

Upon raw cotton and its waste, imported for consumption, no duty is levied; if it be in transit, there is a small duty of 6 kreutzers ($4\frac{4}{5}$ cents per Zollcentners.)

The Report of the Department of Statistics, published by the Directory of Administrative Statistics of the Imperial Ministry of Commerce for the fourth year, Vienna, 1855, gives a complete list of the cotton spinneries of the empire in the year 1854, from which the following table has been compiled:

Provinces.	Mills.	No. of spindles.	Description of yarns, &c.
Upper Austria	47	569,979	No. 6 up to 40, 60, 80, 100, 110, 120, 140.
Lower Austria	9	83,590	No. 4 to 44, 50, 60, 80, 100.
Styria	3	25,464	No. 6 to 40, 100.
Carniola	1	12,000	No. 6 to 40.
Gratz	2	18,300	No. 4 to 44, 4 to 26.
Tyrol	22	214,094	No. 4 to 46, 6 to 46, 10 to 40, 30 to 40.
Bohemia	71	449,906	No. 1, 4, and 6, to 20, 30, 40, 50, 60, 80, 90, 100, 120.
Lombardy	30	129,046	No. 4 to 20, 6 to 20, 6 to 30, 6 to 40, 20 to 100.
Venice	2	28,464	No. 6 to 40.
Hungary	1	1,440	No. 6 to 16, 6 to 20.
Transylvania	1	960	No. 6 to 16.
Total	189	1,533,243	

Several of these mills, also, spin twist, particularly those of Felixdorf, Nos. 30–100 (Truman, 6–140;) and Haratic (20–160.)

It will be perceived that the great bulk of Austrian spun yarns is of the lowest numbers, ranging from No. 4 to No. 50, upon which the tariff affords a very high and almost prohibitive protection.

The yarns produced are mostly unbleached, and a ready home market is found for them.

The demand is principally for middling qualities 16–24, which are worth, ordinarily, in the Triest market $5\frac{1}{2}$ florins ($2 70) the package of 10 pounds. When imported, they are sent chiefly to Hungary, Bosnia, and Wallachia. Bleached yarns of the lower numbers imported cannot ordinarily compete, by reason of the duties, with those of domestic production. At Triest, which is a free port, they are worth, generally, from 4 florins ($1 94) to $4\frac{1}{2}$ florins ($2 18) the package of 10 pounds, and are in demand for the Levant markets. The duty on bleached yarn and twist is $46\frac{1}{3}$ kreutzers (near 36 cents) the package of 10 pounds. On bleached and twisted yarn the duties are $54\frac{1}{2}$ kreutzers (near 44 cents) in the package of 10 pounds, while on those which are dyed it is 1 florin 22 kreutzers (near 65 cents) for the same measure, and they are also excluded from the domestic market by reason of the duties.

The domestic yarns are worth at Prague, which is the great centre of production, the Province of Bohemia having 71 mills and 449,906 spindles out of a total of 1,533,243, from 42 to 45 kreutzers (35 to 36 cents) the pound. This does not, as I was told, materially differ from the prices at other points of Austria.

A very active spinning business is carried on at Prague and the neighboring districts of Bohemia, the raw material being almost wholly supplied by way of Bremen.

The mill of Mr. Richter—the only one visited by me—has 16,000 spindles, employs 500 hands in spinning and weaving, and consumes, on an average, 10,000 pounds of cotton per week, nearly all of which is "middling" Georgia and Louisiana, which, delivered at the mill, cost from 45 florins ($21 83) to 50 florins ($24 25) the centner ($110\frac{355}{1000}$ pounds.)

Surat is used but to a limited extent, and for the lowest numbers, being mixed with the other varieties.

The yarns spun are chiefly Nos. 25 and 26, which are woven into ordinary cloths. The yarn of this and other lower numbers is worth at Prague from 42 to 45 kreutzers ($33\frac{6}{10}$ to 36 cents) the pound. The wages paid are, for a head spinner, from 7 to 8 florins ($3 40 to $3 86) per week. He is allowed one assistant, at 2 florins, (97 cents,) and two boys, one of whom receives 1 florin 48 kreutzers, ($86\frac{2}{5}$ cents,) and the other 1 florin 30 kreutzers (72 cents per week.) For women and girls, the wages are from 15 to 25 kreutzers (12 to 20 cents) per day.

For weavers, the average wages are 3 florins ($1 45) per week. The working day begins at 5 a. m. and ends at 7 p. m., and an ordinary weaver can weave from 24 to 30 Austrian ells (20 to $26\frac{2}{3}$ yards) per week.

Spinning is also carried on in all the other provinces named in the table to a greater or less extent; the difference being mainly in the fineness or coarseness of the yarns turned out. In the two Provinces, (Upper and Lower Austria,) of Austria proper and Styria, a greater proportion of the finer numbers are turned out; but the new material consumed continues to be, for by far the greater part, of the growth

of the United States; and, as observed in a former part of this report, imported for the mills in the Vorarlberg, Vienna, and Styria, by way of Bremen or Hamburg, on account of the superior advantages the first-named city especially presents above Triest or Vienna in the lowness of freights.

The Movimento della Navigazione e Commercio, in Trieste, nell' anno solare 1856—The Progress in Commerce and Navigation, in Triest, for the year 1856—an official publication, gives the following statement of the importation of raw cotton into that port in the year 1856, with the countries or ports from which it came:

	Centners
From Austrian ports	427
Papal States	108
Greece	99
Sardinia	184
France on the Mediterranean	25
France on the Atlantic	470
Malta	12
Great Britain and Ireland	60,594
Netherlands	7
Turkey	5,180
Egypt	102,199
St. Domingo	150
United States	133,020
Total (33,375,326 pounds)	302,430

The exportations for the same period were, by land, 171,387 centners, (18,913,412 pounds,) and by sea as follows:

	Centners.
To Austrian ports	80,180
Papal States	442
Greece	26
Kingdom of Naples	1,449
Ionian Islands	43
Tuscany	38
Turkey	178
Total (9,088,397 pounds)	82,356

The cotton exported to Austrian ports went, as I was informed, into Lombardy, by way of the river Po; and what was not demanded there went over the Alps into Tyrol, the Vorarlberg, and a portion also into Switzerland.

The 171,387 centners exported by land were nearly all sent into Styria, Carniola, Gratz, &c. What effect the completion and putting into operation of the entire railroad line between Triest and Vienna,

which was accomplished last summer, may have upon the importation of cotton, particularly from the United States, the East Indies, or South America, into Triest, remains yet to be seen. The great obstacle to any marked increase is the uncertainty of obtaining return freights for cotton-laden vessels; and unless that be removed, Bremen will probably continue to maintain her supremacy as the entrepôt for the much greater part of the raw material, unless Genoa should deprive her of a portion of the trade, now that the Sandinian and Lombardy lines of railroad are so extensive, and by which means, it is thought, Lombardy, the Tyrol, the Vorarlberg, and even Venice herself, perhaps, may be supplied at a less cost of transportation than by ships going to either Venice or Triest, as that port offers much greater prospects of ready and paying return freights than any of the others.

Through the kind attention of Messrs. S. & A. Blumenthal, bankers, at Venice, I obtained the following statement of the amount and value of cotton imported into that port during the years 1855 and 1856, and for the first seven months of 1857. The weights, French kilogrammes, and the values, Austrian livres, are here reduced to their corresponding values with us:

1855—85,867 pounds; value, $10,820.
1856—99,256 pounds; value, $12,654.
1857—(seven months) 58,123 pounds; value, $7,462.

The condition of the spinning and cotton manufacturing interest in the Lombardo-Venitian Provinces is one of great prosperity, as none but articles which command a ready and profitable home market are turned out, the cost of production, deducting that of the raw material, being quite moderate.

The communication which follows is from the highly respectable firm of Antonio and Andrea Ponti, of Milan, who appeared to take the greatest pleasure in giving information, so far as it related to Lombardy and the other Italian Provinces of Austria.

The importation of raw cotton into Lombardy is estimated at 30,000 bales, of which 25,000 are of the growth of the United States, and 5,000 of the Indies and the Levant; that is, cottons coming from Madras, Bombay, and Surat, and cottons coming from Macedonia, Smyrna, and Malta.

The much greater part of the cotton from the United States, Malta, and the Indies, is received through the port of Genoa, and nearly all those from the Levant are imported by way of Triest, where there is a great entrepôt of those qualities, and formerly a much more considerable importation was counted, but the low prices of cotton, in America, during the years 1840, 1844, 1848, 1849, and 1850, have broken up the culture of cotton in the countries of the Levant.

Before the opening of the railroad from Genoa to Novara, a great deal of the cotton from the United States came in by way of Triest, and was sent to Milan by the river Po as far as Mantua, and afterwards, by wagon, to its destination; but now, the transport by railroad furnishes a more rapid and economical way, and has annihilated

the commerce of Triest as regards that article, Genoa being much nearer to Milan and possessing superior advantages, although the entire line of railway from Milan to Venice and Triest is now open. The transportation from Genoa to Milan, including all expenses of discharging, warehousing, &c., is calculated at $\frac{1}{4}$ cent per dollar on the American pound, while, on the contrary, the transportation from Triest to Milan would cost twice as much and take twice the time.

At Genoa, cotton is bought directly through brokers, without other expense than a commission of one-half of 1 per cent., and is imported at less expense from the country of its growth than at either Triest or Venice.

The first importation of United States cotton into Genoa dates from 1827, by the house of Ponti, a member of which was, in that year, at New Orleans, making direct purchases, and afterwards, in 1841; the writer of this, resided in the United States for the period of eleven years, and carried on trade in this article by way of the Mediterranean, bringing the consumption up to the point at which it now is, while the previous consumption was only one-quarter American to three-quarters Levant. Now many of the largest spinners import cotton direct from the United States, and are able to furnish a good supply to the smaller spinners.

In Lombardy, we count 33 spinning mills of 800 horse power, 500 mule jennies, and 140,000 spindles; of this number, the Province of Milan contains 18 mills of 450 horse power, 300 mule jennies, and 80,000 spindles; the remaining 15 mills are scattered through the adjoining Provinces of Bergamo, Brescia, Sondrio, and Como.

Our Ponti mill, at Gallavati and Solbrata Alona, is the oldest, and dates from 1810. It counts 18,000 spindles, and is the most extensive in Lombardy. The yarn spun ranges from Nos. 2 to 34. The weight and quality are established on the same footing as in England. All its product is consumed in Lombardy and Venice.

The yarns of all the Lombardian spinneries are consumed either in the fabrication of very common stuffs, made of Nos. 2, 4, 8, or 10, which the peasants carry to their homes to be worked up during the winter, making themselves their supply of cloth, or by contractors or wholesale merchants.

The merchandise fabricated by the large manufacturers may be estimated at 300,000 pieces of domestics; 6,000 pieces of velvets; 150,000 pieces of fustian; 170,000 pieces of shirtings; 150,000 pieces of cottonades; 80,000 pieces of other coarse tissues, and for consumption in our country.

The length of the piece cannot be given, for the reason that each manufacturer has his own measure; but it may be estimated at an average of 60 yards.

The principal villages of production are Gallavati, for fustians; Busta, for domestics, fustians, and other stuffs; and Monza, for cottonades. These villages are all in the Province of Milan, and it may be said that they manufacture enough for the requirements of all the other Provinces of Lombardy and a good part of Venice. However, many inhabitants of the country also buy yarns of very coarse descrip-

tions for the fabrication of heavy goods, such as socks, bonnetry, &c. The number of looms worked at Gallavati, Busta, and Monza is estimated at 18,000, and nearly all the cultivators become weavers as soon as they have finished their field work.

The piece costs from $1 to $1 25, according to the fineness of quality, and there are, at the least, 5,000 families who are supplied in this manner. Labor with us is so cheap because it is thus employed at hours and seasons when there is nothing elsewhere to do, and particularly by those members of the families who do not till the soil; that is to say, by children under eight years, and by the aged people above sixty years old.

The most extensive manufacturing firms are those of our house and of M. Turati. It was the first named which introduced, in the year 1808, the fabrication of fustians into Lombardy, with which the lower classes of people are at present clothed.

Accept, sir, our most devoted salutations.

ANTONIO & ANDREA PONTI.

MILAN, *October* 7, 1857.

The importation of cotton yarns and manufactured goods, particularly those which are bleached or colored, is discouraged by the imposition of duties which are in some cases heavy, and in others absolutely prohibitive.

Up to the 30th June, 1856, the quantity of unbleached yarn imported was 50,883 Zollcentners, equal to 5,615,189 pounds, upon which the duty paid was 6 florins ($2 91) per centner; for the remainder of the year, the import amounted to 61,855 Zollcentners, (6,826,009 pounds,) on which the duty paid was 5 florins ($2 42.) The total value was 6,764,280 florins, or $2,279,675; while the total duty paid was 614,573 florins ($298,067.)

Of bleached, but not dyed yarn, the import for the year was only 3,249 Zollcentners, (353,543 pounds,) paying a duty of 10 florins ($4 85) the Zoll centner, and its value was 324,900 florins, ($157,576,) paying a total duty of 32,490 florins ($15,757.) Of dyed yarn and twist, the import was 1,211 Zollcentners (133,641 pounds.) It was valued at 157,430 florins, ($76,353,) which, at the duty of 12 florins 30 kreutzers, or $6 66 the Zollcentner, yielded a revenue of 15,137 florins ($7,341.)

Of this description, there were imported under "the free trade with the Zollverein States," 15,772 Zollcentners (1,740,520 pounds); which paid only 2 florins 30 kreutzers, or $1 22 duty, the Zollcentner. Its value was 2,050,360 florins, ($994,424,) and the revenue derived from it amounted to 39,430 florins ($19,054.)

On bleached, but not dyed yarns, coming in under the same arrangement with the Zollverein States, the duty is only 2 florins 30 kreutzers, ($1 22,) while on unbleached yarns it is levied at the same rate.

Triest being a free port, with an extensive trade with the Levant, Bosnia, Servia, and Wallachia, there is a considerable demand for such qualities and descriptions of yarns as could not, if sent into the

Austrian markets, at all enter into competition witn those of domestic production by reason of the enormous duties. The yarns destined for Triest are generally put up in packages of 10 pounds.

But jealous as the Austrian government shows itself as to competition with its domestic produce of cotton yarns and twist, it is still more so with regard to the introduction of cotton fabrics and tissues; and although it has not gone to the length that France has done, of prohibiting absolutely and in express language, their introduction within its territory, the same object is attained by the imposition of a scale of duties which are virtually prohibitive. Thus, on the most ordinary description of cotton stuffs, "raw, unbleached, undyed, and unprinted," the duty imposed amounts to 40 florins ($19 44) the Zollcentner. On articles of middling fineness, dressed, bleached, dyed, &c., 75 florins ($36 24) the Zollcentner. If from the States of the Zollverein, 45 florins ($21 84). Muslins printed, 100 florins (or $48 24) the Zollcentner. If from the "free trade of the Zollverein States," 45 florins ($21 84). Bobbinets, English tulles, laces, and embroideries, 250 florins ($121 25) the Zollcentner; if from the "free trade of the Zollverein States," 200 florins ($97;) and if from the privileged factories of Venice, 228 florins 40 kreutzers ($110 90.)

With such duties to contend against, it is not to be wondered at that the entire importation of all such fabrics and tissues into the Austrian empire, with its 39,500,000 inhabitants, only amounted, in 1856, to 7,768 Zollcentners, (857,237 pounds,) of the value of 1,769,680 florins ($858,295,) while the revenue amounted to 649,259 florins ($314,890.)

SARDINIA.

Although somewhat later in the adoption of cotton-spinning, and the other branches of manufacture of which our great staple furnishes the material, than many of the Continental States, Sardinia exhibits a healthy state of progress, if an opinion may be formed from the consumption of cotton, in proportion to the population, which, at the last census, was under 5,000,000. It must be remembered that this industry is carried on almost exclusively in Piedmont, while in Genoa, Savoy, and the island of Sardinia it is scarcely, if at all, known.

The mills are, for the most part, to be found at or near the town of Arona, on Lake Maggiore. So far as I could learn, no industrial census of the kingdom is taken, and the number of mills, spindles, looms, and employés was unknown to all those with whom I conversed on the subject. An extensive importer of cotton at Genoa was kind enough to promise me such statistics on these points as he could procure among his customers, but they have not yet come to hand.

The latest official publication relative to the imports and exports of cotton, yarns, and tissues, is the *Movimento Commerciale del' Anno.* 1855, (Commercial Progress for 1855,) published by the ministry of finance

in 1857, which is preceded by some preliminary observations and comparisons of results with those of former years. Of cotton, it is said:

"This class is one of the most important, by value, and the number of commercial contracts to which it gives rise, and of which the united values of the importations and exportations is 40,526,512 livres, ($7,537,931,) with an increase of $6\frac{1}{2}$ per cent. on the last triennial mean, and of $3\frac{1}{2}$ per cent on the import of the preceding year."

The accompanying table, marked *A*, compiled from the official publication above cited, will show the quantity and value of the cotton imported into Sardinia, and the countries whence it came. It will be seen that more than half of it was derived from the United States, while there can be no doubt that by far the greater portion of that reported as coming from France, England, Belgium, &c., was also of the growth of this country. The table marked *B*, also from the same official source, exhibits the import, export and consumption of cotton for the six years beginning with 1850, and ending with 1855. The exportation of the last year named showed an increase of 23 per cent. in the triennial mean, and of 30 per cent. when compared with the year 1854. Mr. Herbremont, the consul at Genoa, kindly furnished me with a statement of the quantities of cotton imported direct into that city from ports of the United States during the year 1856, and the three quarters of 1857, ending with the 30th September, by which it appears that the amount received in 1856 was 39,659 bales, which, at 450 pounds per bale, (a moderate estimate,) would amount to 17,844,300 pounds; which, with the supplies derived from France, England, &c., would go to show a largely increased consumption, compared with the previous year.

Up to September 30, 1857, the direct importation had reached 25,064 bales, which, at the average above assumed, would give 11,278,800 pounds of the raw material from the United States alone. There was, probably, a falling off in the receipts of this year in Sardinia, owing to the short crop of our country and the high prices, as was the case in other European countries.

The export of raw cotton in the year 1855 was, altogether, 4,134,555 kilogrammes (9,096,021 pounds;) of which 3,722,780 kilogrammes (8,290,116 pounds) were sent into the Austrian empire. The quantity, therefore, left for consumption was 9,921,639 pounds.

If the estimate of 40 pounds of the raw material per year to each spindle be applied to Sardinia, the result would be 260,000, which is probably near the truth.

From all I could learn, the qualities of the yarns spun, tissues woven, wages paid, &c., resemble closely the same branches of the industry in Lombardy.

The duty on cotton yarns imported is regulated according to the degree of fineness, it being the object of the government to protect its own spinners against competition in the home market. Thus, on unbleached yarn below No. 20, it is 20 centimes (about $3\frac{7}{10}$ cents;) if between No. 20 and No. 30, 30 centimes (about $5\frac{6}{10}$ cents;) if between Nos. 33 and 45, 40 centimes (about $7\frac{4}{10}$ cents;) if between 46 and 60, 50 centimes (about $11\frac{1}{10}$ cents) the kilogramme of $2\frac{1}{5}$ pounds.

On twisted yarns, up to No. 32, the duty is also $9\frac{3}{10}$ cents the kilogramme, and in all other numbers, 70 centimes (about 13 cents) the kilogramme. On bleached or dyed yarns, of whatever number or quality, the duty is 80 centimes (about 15 cents) the kilogramme.

The accompanying table, marked *C*, exhibits the imports of cotton yarns, tissues, and other fabrics, during the years named. It is also compiled from the "Commercial Progress for 1855."

It is anticipated by the merchants at Genoa that the importations of cotton into that port, direct from the United States, or other countries of its growth, will continue to increase, not only to meet a domestic demand, but also to supply, by means of the Sardinian railroad, the wants of the spinners in the Italian Provinces of Austria, and in those of Tyrol and the Voralberg.

American shipmasters, however, complain no little at the want of liberality on the part of the authorities, as regards the port regulations, and the monopolies, with their exorbitant charges, which they sanction.

There are few or no direct exchange operations between Sardinia and the cotton marts of the United States. Payments are made by drafts on London or Paris. The chief articles of export are fruits, olive oil, silk, rice, wool, wine, grain, &c.

A.

Statement of the cotton imported into Sardinia, from all quarters, during the year 1855, with the declared commercial values; and also the official values, &c., &c.; weights and values being reduced to those of the United States.

Countries whence brought.	General commerce.						Special commerce.					
	Mode of transport.			Total, pounds	Declared commercial value.	Off. value of importation. Total.	Mode of transport.			Total, pounds.	Declared commercial value.	Official value.
	By land	By Nat. C. H	By For. C. H				By land.	By Nat. C. H.	By For. C. H			
France	525,890	314,195	703,826	1,543,912	$170,240	$294,747	525,910	314,195	703,802	1,543,907	$170,419	$294,746
Belgium	30,290			30,290	3,674	5,783	30,290			30,290	3,674	578,256
England		414,147	3,655,639	4,059,785	454,992	775,050		400,077	3,336,845	3,736,922	422,998	713,412
The Duchies		105,591	22,009	127,600	14,311	24,360		105,591	22,009	127,600	14,301	24,360
Switzerland	111,272			111,272	12,250	21,243	111,272			111,272	12,251	21,243
Tunis		352		352	18	67		352		352	18	67
Turkey		6,292	5,060	11,352	3,321	2,167		6,292	5,060	11,352	1,321	2,167
United States	51,845	1,709,299	9,860,653	11,621,797	1,306,435	2,221,706	51,845	1,709,299	9,860,653	11,621,797	1,306,425	2,218,707
Brazil		8,040		8,040	707	1,344		8,040		8,040	707	1,344
South America		159,971	16,500	176,471	18,991	33,690		159,997	10,560	170,531	18,424	32,556
Central America			7,084	7,084	744	1,352			7,084	7,084	3,150	1,352
North America			557,700	557,700	59,241	86,310			557,500	557,500	59,241	106,470
East Indies			765,006	765,006	83,988	146,046			765,006	765,006	83,988	146,046
Total	719,297	2,717,787	15,593,477	19,020,661	2,126,902	3,613,865	719,317	2,703,853	15,268,519	18,691,653	2,096,917	4,140,736

Note.—In the kingdom of Sardinia there exists the same distinction, as general and special commerce, as in France, Belgium, Tuscany, &c.

B.

Statement of the importation, exportation, and consumption of cotton during the years 1850 *to* 1855, *inclusive, derived from the "Commercial Progress" for* 1855; *the weights being reduced to pounds.*

YEARS.	Importation.	Exportation.	Consumption.
1850	....	....	7,210,940
1851	19,019,772	9,172,073	9,845,939
1852	20,313,018	6,722,418	13,590,590
1853	21,772,428	8,067,11[illegible]	14,365,318
1854	17,490,041	6,723,121	10,766,930
1855	19,017,660	9,096,021	9,923,639

C.

Statement of the quantity of cotton, yarns, tissues, and other fabrics imported into Sardinia during the years specified, taken from the "Commercial Progress" for 1855, *and the weights reduced to those of the United States.*

YEARS FROM—	Cotton yarns.	Tissues of cotton, raw or bleached.	Tissues dyed.	Tissues printed.	Cotton velvet.	Ordinary bonnetry.
1844 to 1850	218,238	298,712	442,504	566,082	131,204	10,413
1851	174,220	661,602	714,459	978,385	200,367	34,434
1852	189,455	602,261	786,279	1,414,903	207,522	33,944
1853	175,182	562,120	820,653	1,279,989	161,113	32,555
1854	163,238	590,253	859,883	1,206,115	155,784	39,197
1855	183,588	735,108	949,432	1,340,379	187,557	52,490

BELGIUM.

There exists no official return of the number of spinning mills, spindles, looms, &c., in the kingdom. An industrial census, very imperfect in execution, was taken in 1846, but little reliance seems to be placed in the information which it afforded; besides which, there has unquestionably been a marked progress in the manufacture of cotton since that date. M. Romberg, director of the division of industry of the ministry of the interior, in his *Annual of Industry, Commerce, and Banking, in Belgium*, the first volume of which was published last year, makes an approximative estimate, based on the mean consumption of raw cotton at the time he wrote, 22,200,000 pounds, and in the supposition that each spindle consumed yearly 44

pounds of the raw material, whereby he arrives at the conclusion that their number is about 500,000. It has already been seen that cotton-spinning was a branch of Belgian industry previous to the year 1801, when the first mule jenny was introduced at Ghent. The history of that and other departments of cotton manufacture in the country, down to the period of the breaking up of the first French empire, is to be traced in what has already been said on the same subjects under the head of France. As a portion of Holland, and since her independence of that kingdom, Belgium does not appear to have advanced so rapidly in this as she has in several other branches of industry, although it has now attained to considerable importance, and is on the increase both as to the extent of consumption of raw material and the value of its products.

The accompanying table *A* is a statement of the quantities of cotton imported during the six years, beginning with 1850 and ending with 1855, with the countries whence it came. The total value of the importations in 1855 was 13,541,941 francs ($2,511,000.) Of the 10,534,318 kilogrammes, (23,175,500 pounds,) the value was 11,418,341 francs, ($2,123,811,) and of the 1,784,964 kilogrammes (3,926,921 pounds) in transit, it was $730,407.

The quantities of cotton in transit during the years 1850 to 1855, inclusive, were as follows:

1850	2,580,538	pounds.
1851	4,140,697	"
1852	14,230,153	"
1853	8,044,399	"
1854	6,836,437	"
1855	3,926,921	"

The entire importation of cotton yarn, in 1855, amounted to 1,662,249 kilogrammes, (3,656,948 pounds,) of the value of 6,844,095 francs ($1,273,002.) Of this, 194,723 kilogrammes, (428,391 pounds,) of the value of 1,572,273 francs ($292,443) were consumed in the country, and 1,462,205 kilogrammes, (3,216,851 pounds,) of the value of 5,258,430 francs, ($1,015,268,) was in transit. By far the greater portion of this yarn was neither twisted nor dyed, and of English production.

Of the entire exportation for the year, which amounted to 1,784,608 kilogrammes, (3,926,127 pounds,) of the value of 6,323,653 francs, ($1,236,199,) the Belgian yarns amounted to but 323,403 kilogrammes, (711,487 pounds,) of the value of 1,065,223 francs ($198,131.) Of these, 69,683 kilogrammes (153,303 pounds) were not twisted ncr dyed, and 252,649 kilogrammes, (555,828 pounds,) of the value of $164,474, were twisted and dyed; and 71 kilogrammes, (156 pounds,) of the value of 6,745 francs, ($1,254,) were of various descriptions of yarns above No. 140. Much the greater part of these yarns was sent into Prussia.

M. Romberg, in the work above cited, says: "Belgium imports and exports cotton yarns to an amount nearly equal on each side;

(approximatively, 200,000 kilogrammes per year;) but, as to their value, the balance leans very sensibly in favor of the importation. The yarns which we receive from abroad are of fine numbers, or twisted and dyed, while we send out above all ordinary qualities. One would not be far from the truth in estimating the total value of the yarns produced by our factories at 26,500,000 francs ($4,929,000.)" He estimates the average value of the yarns produced at 2 francs 50 centimes (47 cents) the kilogramme of $2\frac{1}{5}$ pounds, which corresponds with the information obtained by me from several of the spinners at Ghent, which is the seat of that branch of industry. M. Romberg also adopts the opinion that fabrication quadruples the value of the raw material used, and considers that the value of Belgium cotton manufactures, on this hypothesis, would reach from 48,000,000 to 50,000,000 francs, equal to from $8,928,000 to $9,300,000.

Of cotton tissues, the total import, in 1855, was 774,504 kilogrammes, (1,703,909 pounds,) of the value of 11,396,493 francs ($2,101,800;) of which 240,731 kilogrammes, (529,608 pounds,) of the value of 3,486,241 francs ($648,441) were consumed, and 533,263 kilogrammes, (1,173,179 pounds,) of the value of 7,903,459 francs ($1,469,400) were in transit. The export of the same was 2,222,678 kilogrammes, (4,889,892 pounds,) of the value of 18,882,183 francs ($3,496,800;) of which 1,689,415 kilogrammes, (3,716,713 pounds,) of the value of 10,978,734 francs ($2,027,400) was of domestic production. I was told that the articles principally produced were twills, pantaloon stuffs, and bleached or unbleached domestics.

The above figures, except where credited to the Annual of M. Romberg, are official, and derived from the statement of the commerce of Belgium for the year 1855, published in the year 1857, by the ministry of finance. The statement for the year 1856 had not appeared up to the 1st of November last.

At Antwerp, the custom-house authorities were kind enough to furnish the following statement of the import of cotton into that port between January 1st and October 31st, 1857. The weights are reduced to our standard.

For consumption.

	Pounds
From Sweden	65,300
" England	5,305,573
" English East Indies	3,333,585
" United States	11,414,955
" Hayti	63,668
" Brazil	42,242
Total	20,225,323

In warehouse.

	Pounds.
From the United States	1,098,592

In transit.

From England	232,747
" United States	40,759
Total	273,506

The number of people employed in the different branches of the cotton manufacture is estimated by M. Romberg to be from 26,000 to 28,000. The census of 1855 gave the entire population of Belgium at 4,607,065.

At Ghent, I visited the mills of MM. Lonsberg and Jules de Hemptieme; the first named was then running 41,000 spindles, which were soon to be increased to 70,000, consuming Louisiana cotton of the lower classifications, which were converted into yarns No. 30. His importations were mostly direct. The loss on American cotton for spinning was ordinarily 10 per cent.; on good qualities of Surat, about 15 per cent.; on the inferior qualities, 25 per cent. The waste on American cotton is often mixed with East India cotton, to make heavy, coarse yarns. Of Egyptian, Surinam, and Brazilian cotton, the consumption is insignificant. Weaving is also carried on, the tissues produced being of ordinary low-priced qualities, particularly figured or *façonnés* patterns. Number of hands employed between 1,200 and 1,300; wages for ordinary hands—men, 2 francs (37 cents;) spinners, from 3 to 4 francs (55 to 74 cents;) weavers, from 2 francs to 2½ francs (37 to 47 cents) per day. For women, the wages are 25 per cent. less.

M. De Hemptieme consumes East India cotton exclusively, which he converts into yarns from Nos. 4 to 18, with a loss in the raw material of 20 per cent. Delivered at the mill, it costs about 6 pence the pound, and he thinks that its consumption will rapidly increase in Belgium, as American has reached so high a price. The yarns spun are worth, on the average, 2 francs 50 centimes the kilogramme, (46½ cents for 2⅕ pounds,) with a ready sale. The wages paid are—for men, from 12 to 13 francs ($2 23 to $2 40) per week; for boys, from 4 to 6 francs (74 cents to $1 12;) for women drawing frames, 7 francs, ($1 30,) and on bobinet frames, 10 to 13 francs ($1 86 to $2 42) per week.

On all raw cotton imported into Belgium, there is no duties whatever levied. On yarns, simple and undyed, from England, valued by law at 2 francs 50 centimes (46½ cents) the kilogramme, the duties are 84 francs 80 centimes ($15 78) the 100 kilogrammes, or 221 pounds; if from other countries, they are duty free. On twisted and dyed yarns

the duty valuation is 10 francs ($1 86) the kilogramme, and the duties 106 francs ($19 72) per 100 kilogrammes (221 pounds.) On simple and double twist, unbleached, bleached, or dyed, above No. 140 in fineness, the valuation is 95 francs ($17 67) the kilogramme, and the duties 5 francs (93 cents) per 100 kilogrammes (221 pounds.)

On cotton tissues, if unbleached or bleached, the valuation is 14 francs ($2 60) the kilogramme, and the duties 180 francs 20 centimes ($33 52) the 100 kilogrammes. On dyed and printed tissues, if of Prussian or English fabrication, the valuation is 15 francs ($2 79) the kilogramme, and the duties 325 francs ($60 45) the 100 kilogrammes; if of French fabrication, the duties is 212 francs ($39 43) the 100 kilogrammes. From all other countries these articles are free of duties.

Cotton-spinning, like all other branches of industry, is prosperous and advancing with the Belgians. Traverse the country in whatever direction he may, the traveller scarcely ever loses sight of the tall chimneys of the factories, and he is frequently at a loss whether to admire most its evidences of high agricultural advancement or those of manufacturing activity which meet him at every turn.

To Mr. James G. Clarke, acting United States Chargé d'affaires at Brussels, and to M. Lambermont, of the ministry of finance, I was much indebted for the facilities and information they procured me.

A.

Statement of the cotton imported into Belgium during the years specified; compiled from the "Tableau général du Commerce avec les pays etrangers pendant l'année, 1855," in United States pounds.

Whence imported.	1850.	1851.	1852.	1853.	1854.	*1855.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
England	7,303,861	9,270,408	10,297,493	12,203,407	14,061,953	11,130,678
Netherlands	127,774	52,666	193.424	227.438	2,642,407	1,294,075
France	110,279	234,464	304,638	413,750	355,440	1,536,603
Sardinia	....	....	....	....	....	55,143
English East Indies	....	....	....	....	....	170,720
United States	14,398,329	11,791,434	15,814,482	11,700,130	10,626,645	12,530,126
Hayti and Venezuela	40,143	26,200	26,345	18,370	93,740	53,350
Other countries	22,842	....	11,590	....	19,547	39,065
Total pounds	22,003,228	21,375,172	36,647,972	24,563,097	27,799,732	26,809,760

* For the years 1850 to 1854 inclusive, the above figures represent the importation under the head of "Special Commerce," that is, where the importation was declared at the period of entry to be for consumption. For the year 1855, the figures represent the importation under the head of "General Commerce;" that is, without regard to the ulterior destination of the article.

CONCLUSION.

In conclusion it may be said that it would be difficult to overestimate the importance of cotton in the movement of the industry and commerce of the civilized world. Since the inventions of Arkwright and Watt, in England, and Whitney, in our own country, its manipulation and fabrication have become so comparatively easy and cheap, and its adaptation to supply the wants or the luxuries of man have proved to be so multifarious, that the question of an adequate supply of it to the growing demand has become one of the very highest importance, being exceeded in interest by that of the Cereals alone. Its influence in the well-being of the masses by furnishing employment, sustenance, and cheap clothing has long since been fully admitted; and such has been the impetus afforded by it to the invention and improvement of manufacturing machinery, that, in his work, before quoted, M. Audiganne remarks that, "It was certainly a curious sight, that, of the different aliments afforded by cotton to labor, and the services rendered to man at this day by this substance, of which the consumption has increased tenfold four or five times in less than sixty years. Cotton is manufactured among the greater part of the nations that figured at our side in the Palace of Industry. Nearly all had sent there samples of their fabrication—samples more or less numerous, more or less remarkable, but always worthy of attentive examination. *The degree of advancement of each people in the career of industry might be measured by its skill in the treatment of cotton.*"

Illustrating its commercial and political influence as between the United States and Great Britain, Dr. Engel says of it: "That England and the United States are bound together by a single thread of cotton, which, weak and fragile as it may appear, is, nevertheless, stronger than an iron cable."

No wonder, then, that the question of the adequate supply of this mighty and all-powerful agent soars at this day so far above many which, at the beginning of the present century, far outranked it in their bearings upon the interests of civilized man; and it may not, in this connexion, be deemed out of place to allude, briefly, to the history of the supply in Great Britain, which has long been the principal receiver of the raw material, not only to meet her own growing demands, but to be distributed, to some extent, among those European countries which commercial supremacy has made tributary to her.

Cotton planters and manufacturers are alike under great obligations to Joseph Rudworth Sharp, F. H. S., of London, for his valuable tables, published in September last, which exhibit in a clear and comprehensive manner, the gross amount of receipts per year, with quinquennial averages, and the countries of production of the cotton received in the United Kingdom, &c., from the year 1821 up to 1855. These tables are admirably arranged, and must have cost an immense amount of labor to their compiler; and with full acknowledgment of

the very great aid they have been to me, the second of them is annexed hereto, as affording, in a clear and succinct form, the best information attainable on that subject.

It will be seen from this statement how vast has been our own contribution of the raw material to Great Britain and Europe generally, and how much more reliable as a source of supply our cotton fields are than those of any or all other countries, as their production between 1851 and 1855 was five times that of the East Indies, and that, while during that period, all other countries exported to Great Britain 937,024,275 pounds, our own sent her 3,424,502,024 pounds, or more than three and a half times as much.

In his first table, Mr. Sharp sets down the import from the United States into the United Kingdom, in 1856, at 780,040,016 pounds, that from the East Indies at 180,496,624 pounds, and the total from all other countries than the United States at 243,846,512 pounds, leaving a balance in our favor of 536,193,504 pounds, and also showing that in that year also we contributed more than three times as much to European supply than all other countries combined, while it must be remembered that our domestic consumption was advancing so rapidly as to require for its use 652,739 bales, which, estimated at 450 pounds each, were equal to 293,732,550, or more than the import into England that year from all other countries than our own.

Mr. Samuel S. Littlefield, editor of the New Orleans Price Current, than whom there is no better informed or more reliable authority on the subject of cotton and the cotton trade in the Union, estimâtes the value of our crop of 1857, 2,931,519 bales, after making all allowances for differences in their weights in different sections of the country, at an average of $50 per bale, making the total sum of $146,975,950. This gentleman has also furnished me with much interesting information, and several valuable suggestions.

From what has been said under the various heads of this report, the following conclusions as to the influence of raw cotton among the nations who are our chief customers for it may be drawn:

1st. That it contributes vastly to their social well-being by furnishing labor, sustenance, and cheap and comfortable clothing to many thousands of their subjects or citizens.

2d. That to commerce, it contributes immensely by furnishing a great variety of articles, by which its exchanges are in a considerable degree regulated, and large profits continually realized. That to capital, it offers the means of profitable investment and returns, and aids greatly in its accumulation.

3d. That its political influence arises from the fact, that, by opening and extending commercial relations between different nations, it has created sympathies and ties of common interest, which make the policy of peace and its attendant blessings far more easy to maintain than was once the case; that it adds to the national wealth and resources, and by furnishing employment and support to many thousands who might otherwise be without either, it makes contented those who would, through idleness or suffering, become burdens to the State.

4th. That the permanent and adequate supply of raw cotton thus becomes to Great Britain and Continental Europe a subject of vital importance, and indeed of absolute necessity; and that any considerable diminution in the crop of the United States would cause the gravest inconveniences, while the occurrence of any state of things whereby it should be entirely cut off would be followed by social, commercial, and political revulsions, the effects of which can scarcely be imagined.

With high consideration, I am, sir, your obedient servant,

JOHN CLAIBORNE.

Hon. Joseph Holt,
Commissioner of Patents.

Abstract of the trade in cotton, showing the import into, export from, and consumption in this and the several foreign countries, (except the consumption in the United States,) and the export of cotton yarns and cotton manufactured goods from this country, with the respective total amounts for the seven several terms of five years each, from 1821 *to* 1855, *both inclusive, and the grand totals and annual averag s for the entire period of thirty-five years. Compiled by Joseph Rudworth Sharp, Myddleton Square, London, September,* 1857.

TOTAL QUANTITY AND VALUE OF COTTON EXPORTED FROM THE UNITED STATES.

1.	2.	3.	4.	5.	5.*	6.	7.
QUINQUENNIAL PERIODS.	SEA ISLAND. Total quantity in each period.	ALL OTHER SORTS. Total quantity in each period.	ALL SORTS. Total quantity in each period.	ESTIMATED VALUE AS SHIPPED. Total value in each period.	Reduced to sterling money.	Value per lb. in Am. currency.	Value per pound in sterling.
Years included.	Pounds.	Pounds.	Pounds.	Dollars.	£	Cents and decimal parts.	P'nce and decimal parts.
From 1821 to 1825	53,922,389	708,188,951	762,111,340	123,432,112	25,715,023	16.19	8.95
From 1826 to 1830	53.382,541	1,219,349,740	1,272,732,281	133,122,182	27,733,788	10.46	5.23
From 1831 to 1835	44,036,795	1,651,933,614	1,695,970,409	207,614,983	43,253,121	12.24	6.12
From 1836 to 1840	35,004,803	2,586,355,611	2,621,360,414	321,191,121	66,914,817	12.25	6.12
From 1841 to 1845	36,495,303	3,407,262,371	3,443,757,674	256,846,755	53,507,741	7.05	3.52
From 1846 to 1850	43,612,376	3,507,423,941	3,551,036,317	296,563,066	61,783,972	8.35	4.17
From 1851 to 1855	54,687,909	5,073,547,896	5,128,235,805	491,169,517	102,326,983	9.58	4.79
Grand totals for the whole period of 35 years	321,142,116	18,154,062,124	18,475,204,240	1,829,939,736	*381,237,445	--------	--------
Annual averages for the whole period of 35 years	9,175,489	518,687,489	527,862,978	52,283,992	10,892,498	9.90	4.95

* Of this sum it would be difficult to affix the *exact value* shipped to this country; but as the quantity received by us from the United States constitutes 70 per cent. (69.93, see column 16) of their entire export, and as the Sea Island cotton, the most valuable imported, is chiefly consumed here, it would be a reasonable computation to estimate the British amount of this value at something more than the exact arithmetical proportion, or say, £270,000,000. being an average, for the whole term, of nearly £8,000,000 per annum as valued in America.

ABSTRACT—Continued.

TOTAL IMPORTS OF COTTON INTO THE UNITED KINGDOM FROM ALL COUNTRIES.

QUINQUENNIAL PERIODS.	8.	9.	10.	11.	12.	13.
	Total imports in each period from the United States.	From the East Indies.	From the West Indies.	From the Brazils.	From all other countries.	Total imports in each period from all other countries.
Years included.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
From 1821 to 1825	569, 130, 984	64, 646, 326	38, 932, 141	125, 785, 676	45, 667, 041	844, 162, 164
From 1826 to 1830	867, 608, 058	111, 443, 139	25, 880, 412	121, 700, 991	37, 913, 215	1, 164, 545, 815
From 1831 to 1835	1, 230, 256, 026	168, 088, 818	10, 636, 039	124, 546, 947	36, 214, 773	1, 569, 742, 603
From 1836 to 1840	1, 841, 159, 598	291, 884, 429	6, 953, 716	104, 657, 072	59, 326, 171	2, 303, 980, 986
From 1841 to 1845	2, 490, 879, 279	403, 147, 693	6, 488, 885	91, 811, 676	68, 699, 263	3, 061, 026, 814
From 1846 to 1850	2, 494, 453, 334	392, 289, 975	3, 809, 447	115, 722, 736	68, 356, 431	3, 074, 629, 923
From 1851 to 1855	3, 424, 502, 072	654, 412, 793	2, 378, 215	114, 317, 428	165, 915, 539	4, 361, 526, 047
Grand totals for the whole period of 35 years	12, 917, 989, 369	2, 085, 911, 173	95, 078, 855	798, 542, 526	482, 092, 433	16, 379, 614, 352
Annual averages for the whole period of 35 years	369, 085, 411	59, 597, 462	2, 716, 539	22, 815, 501	13, 774, 070	467, 988, 981

ABSTRACT—Continued.

QUINQUENNIAL PERIODS.	14. Total quantity exported from the United Kingdom in each period.	15. Total quantity remaining for home consumption in each period.	16. Per-centage of exports from the United States to the United Kingdom.	17. Per-centage of exports from the United States to all other countries.	18. Total quantity shipped from the United States to all other ports than the United Kingdom.	19. Total quantity exported from the United States and United Kingdom to all foreign countries.
Years included.	Pounds.	Pounds.	Per cent.	Per cent.	Pounds.	Pounds.
From 1821 to 1825	73, 482, 133	770, 680, 031	74. 68	25. 32	192, 980, 356	266, 462, 489
From 1826 to 1830	98, 829, 957	1, 065, 715, 858	68. 17	31. 83	405, 124, 223	503, 954, 180
From 1831 to 1835	114, 942, 074	1, 454, 800, 529	72. 54	27. 46	465, 714, 383	580, 656, 457
From 1836 to 1840	179, 517, 730	2, 124, 463, 256	70. 24	29. 76	780, 200, 816	959, 718, 546
From 1841 to 1845	210, 683, 744	2, 850, 343, 070	68. 36	31. 64	952, 878, 375	1, 163, 562, 119
From 1846 to 1850	416, 268, 048	2, 658, 361, 875	70. 25	29. 75	1, 056, 582, 983	1, 472, 851, 031
From 1851 to 1855	620, 006, 256	3, 741, 519, 791	66. 78	33. 22	1, 703, 733, 733	2, 323, 739, 989
Grand totals for the whole period of 35 years	1, 713, 729, 942	14, 665, 884, 410	----------	----------	5, 557, 214, 869	*7, 270, 944, 811
Annual averages for the whole period of 35 years	48, 963, 713	419, 025, 269	69. 93	30. 07	158, 777, 567	207, 741, 280

* It is not pretended that this is the *extreme amount* of consumption in foreign countries, since some of them may possibly obtain limited quantities direct from Brazil, the Mediterranean, or elsewhere, and, in the case of France and Holland especially, from their own colonial possessions. But the quantities thus obtained will be of comparatively trifling extent, and cannot materially change the relative proportions or per-centage of entire consumption in the United Kingdom and foreign countries, as shown in columns 19*a* and 19*b*.

It may be well shortly to state here, that the quantity of cotton worked up in the United States last year was 652,739 bales, which, at an average of 400 pounds per bale, gives 261,000,000 pounds so manufactured in that country.

ABSTRACT—Continued.

QUINQUENNIAL PERIODS.	19*a*. Per-centage of total consumption in the United Kingdom.	19*b*. Per-centage of total consumption in all foreign countries except the United States.	20. Quantity of cotton yarns exported from the United Kingdom to all parts of the world.	21. Declared value of cotton yarns exported.	22. Declared value of cotton manufactured goods exported.
Years included.	Per cent.	Per cent.	Pounds.	Value.	Value.
From 1821 to 1825	74. 31	25. 69	141, 747, 937	£13, 971, 492	£72, 565, 552
From 1826 to 1830	67, 89	32. 11	263, 650, 779	18, 742, 936	67, 199, 504
From 1831 to 1835	71. 47	28. 53	369, 807, 417	24, 319, 406	71, 464, 481
From 1836 to 1840	68. 88	31. 12	530, 399, 451	34, 467, 678	84, 127, 222
From 1841 to 1845	71. 00	29. 00	674, 699, 531	36, 184, 222	84, 366, 254
From 1846 to 1850	64. 35	35. 65	698, 867, 302	32, 855, 652	93, 791, 134
From 1851 to 1855	61. 69	38. 31	749, 611, 755	34, 106, 092	125, 131, 296
Grand totals for the whole period of 35 years	....	....	3, 428, 784, 172	194, 647, 478	598, 645, 443
Annual averages for the whole period of 35 years	66. 85	33. 15	97, 965, 262	5, 561, 357	17, 104, 156

METEOROLOGY.

METEOROLOGY IN ITS CONNECTION WITH AGRICULTURE.

BY PROF. JOSEPH HENRY, SECRETARY OF THE SMITHSONIAN INSTITUTION.

We intended, in this number of our contributions to "Meteorology as applied to Agriculture," to give an account of the distribution of rain, of the phenomena of storms, and other matter pertaining to the climate of the United States; but the colored plates necessary to illustrate this subject were not ordered by Congress at its last session, and, therefore, we are obliged to change our plan. We have concluded to occupy the space allowed us in the Report of the Patent Office, with a more definite exposition of some of the general principles of science, especially applicable to meteorology, than is generally met with in elementary works. We are induced to adopt this course on account of the inquiries which we are constantly receiving in regard to subjects of this class from all parts of the country; a great interest having been awakened during the last few years in the study of meteorology, principally through the efforts of the Smithsonian Institution and the Patent Office. We trust that our essay will be acceptable to the agriculturist, since, however remote the theoretical part of the communication may appear, at first sight, from his pursuits, yet a proper view of the relation of science and art will enable him to see that the one is dependent on the other, and that each branch of the study of Nature is intimately connected with every other.

We take it for granted that the American farmer is capable of logical reflection; that he is not content with the ability merely to perform with facility agricultural operations, and to direct with skill the ordinary routine of his farm, but that he is, also, desirous of knowing the rationale or scientific principles of all the processes he employs. We have no sympathy with the cant of the day with reference to "practical men," if by this term is understood those who act without reference to well-established general laws, and are merely guided by empirical rules or undigested experience. However rapidly and skilfully such a person may perform his task, and however useful he may be within the limited sphere of his experience, and in the practice of rules given by others, he is incapable of making true progress. His attempts at improvement are generally not only failures, involving a loss of time, of labor, and of materials, but such as could readily have been predicted by any one having the requisite amount of scientific information. It is the due combination of theoretical knowledge with

practical skill which forms the most efficient and reliable character, and it should be the object of the agricultural colleges which are about being established in various parts of our country to produce educational results of this kind.

It is not expected that the farmer is to be a professional scientist, but that he should be familiar with the general principles of all branches of knowledge which more especially relate to his occupation; and the wider the extent of his information, the better. Above all, he should be qualified to form a just appreciation of the value of original scientific investigations, and be ready at all times to adopt the principles which they may unfold, so far as they may be applicable to his uses; and, moreover, be willing to render a due acknowledgment for the benefits thus conferred, and to contribute in any way in his power to the necessary, if not liberal, support of those who seek, without the hope of pecuniary reward, to advance the bounds of human knowledge and of human power. The number of those in any age, and in any country, who successfully investigate Nature and discover new truths, which form valuable contributions to the existing stock of knowledge, is comparatively small. The successful labor of the hands is much easier than that of the head; and, therefore, those who have actually proved by what they have done that they possess the ability to enlarge the field of science, should be especially cared for, and their energies husbanded and directed to the one pursuit to which they may have devoted their attention. Unfortunately, however, there has always been in England and this country a tendency to undervalue the advantages of profound thought, and to regard only with favor those investigations which are immediately applicable to the wants of the present hour. But it should be recollected that the scientific principles which at one period appear of no practical value, and are far removed from popular appreciation, at another time, in the further development of the subject, become the means of individual prosperity and national wealth.

About fifty years ago Sir Humphrey Davy moistened a small quantity of ordinary potash, and, submitting it to the current of a powerful galvanic battery, observed a number of brilliant particles burning and exploding on the surface. With the intuitive perception of a highly philosophical mind, he saw at once, in this experiment, a fact of the deepest significance—the verification of a previous a priori hypothesis, namely, that potash and the other alkalies and alkaline earths were not simple substances, as they had previously been considered, but metals compounded with oxygen. This discovery, which had an important bearing on the whole science of chemistry, but which had no interest for the popular mind, has, in the course of time, revolutionized many of the processes of art, and will furnish the means, in various ways, of adding to the comforts and conveniences of life. Within the last two years a French chemist has discovered a process of decomposing one of these alkaline earths, namely, the clay, which forms the basis of the soil of the farmer, and which, hardened by fire, constitutes the brick to build his tenement, and of obtaining from it a metal as light as glass, as malleable and ductile as copper,

and as little liable to rust as silver. These discoveries were made by men whose lives were devoted to the abstract study of Nature; they are not the results of accident, but logical deductions from previous conceptions of the mind, verified and further developed by the ingenious processes of the laboratory. It may be safely said, that for every one individual who is capable of making discoveries of this kind, there are at least a thousand who can apply them to useful purposes in the arts, and who will be stimulated to undertake enterprises founded upon them by the more general and powerful incentive of pecuniary reward. When the process of procuring aluminum, or, in other words, the metal from clay, has been perfected, and some enterprising citizen shall have established a great manufactory for the production of the article for general use, he will have conferred a benefit on his country, be entitled to credit, and will probably receive the desired remuneration. But should the names of the chemists who originally made the discovery of the principles on which this public benefit depends be forgotten? Ought not their labors to enlarge the bounds of knowledge to be properly valued, and their names held in grateful remembrance? If living, should they not be afforded the means of extending their investigations, without the distraction of mind attendant on the efforts to obtain a precarious livelihood for themselves and families?

In truth, we must say, not in the way of complaint, but for the purpose of drawing attention to the fact, and with the hope of somewhat changing the condition of things in this respect, that in no civilized country of the world is less encouragement given for the pursuit of abstract science than in the United States. The general government has no power in the Constitution directly to foster pursuits of this kind; and it is only by an enlightened public opinion, and the liberality of wealthy individuals, that a better condition of things can be hoped for.

The great facts of the future of agriculture are to be derived from the use of the microscope, the crucible, the balance, the galvanic battery, the polariscope, and the prism, and from the scientific generalizations which are deduced from these by the profound reflections of men who *think*, in contradistinction to those who *act*. The intelligent farmer should be able, as we have already said, properly to appreciate the value of scientific discoveries; and for this purpose his studies should not be confined merely to rules or empirical receipts, but also to the general principles on which they are or should be founded.

Though some of the points we shall discuss in the following essay may appear, at first sight, to be of too abstract a character to be comprehended by a casual reader, yet they will be found, on attentive perusal, by a person of ordinary intelligence, to be easily understood; but it may be well here to call attention to a fact frequently overlooked, that there is a great difference between *reading* and *study*, or between the indolent reception of knowledge without labor, and that effort of mind which is always necessary in order to secure an important truth and make it fully our own.

CONSTITUTION OF MATTER.

Laws of force and motion.—All the objects which are presented to us in the material universe, and all the changes which we observe taking place continually among them, whether those which immediately surround us or those which we perceive at a distance, either by the naked eye or by means of a telescope, are referable to two principles—*matter* and *force.* By the former, we understand the substratum of that which affects our senses; and by force, that which produces the changes which we constantly observe in the former. The idea of force, was probably first suggested to us by our muscular exertions, and, indeed, the original meaning of the term is a muscle or tendon. But we cannot imagine a force without some bodily substance against which it is exerted; the two ideas, therefore, of matter and force are coexistent in the mind, and on a clear and definite conception of them depends that precise relation of the phenomena of Nature denominated *science.* Though the essence of force and matter may never be known to us, we can study the laws by which they are governed, and adopt such a constitution of matter as will enable us to generalize a vast number of facts; to connect these with each other, or, as it were, with a central thought; to perceive their dependencies, and in some cases to control phenomena; to relieve the memory, and call into play the reasoning powers; and, finally, to predict new facts, the existence of which had never yet been proved by actual experience. But such a generalization must be based on the well-established principles of the laws of force and motion, and be in strict accordance with accurately ascertained and properly estimated facts in the various branches of physical inquiry, in order that it may be an exact expression of the apparent cause of the phenomena, and that the prediction from it may be true in measure as well as in mode.

The laws of force and motion, to which we have alluded, may be expressed as follows:

LAWS OF FORCE.

1. Every particle of matter, at a sensible distance, attracts every other particle with a force varying inversely as the square of the distance. In electricity and magnetism, repulsion is also exhibited, acting in accordance with the same law.

2. Particles of matter attract and repel each other with great energy, the attractions and repulsions appearing to alternate.

LAWS OF MOTION.

1. *The law of inertia.*—A body at rest tends to remain at rest, and when put in motion by the application of any force, tends to move forever in a straight line with a uniform velocity.

2. *The law of the coexistence of motions.*—A body impelled at the

same moment by several forces in different directions, will, at the end of a given time, be in the same position as if the forces had each acted separately.

3. *The law of action and reaction.*—When a force acts between two bodies of different masses, their momenta will be equal.

These laws were first given to the world in a definite form by Sir Isaac Newton, in his Principia. They are ultimate facts of science, of which no satisfactory explanation is given; but by adopting them, as we do the axioms of geometry, and reasoning downward from them, all the great truths of modern astronomy have been evolved, as well as many of the facts of the molecular action of bodies.

ATOMIC THEORY.

In connection with the laws of the forces and motion of matter, given above, we shall venture in this essay to express some of the widest generalizations of the present day in the form of what is called the *atomic theory*. This was the original conception of an imaginative Greek philosopher, but in his mind it did not take that definite character which it has since assumed under the influence of inductive science. It was with him the vague and indefinite product of the imagination, unconditioned by the actual phenomena of Nature. It was adopted by Newton, who employed it with much success in the different branches of his investigations; but in modern times it owes its greatest development and practical application to Dr. John Dalton, of Manchester, England, and still later principally to Mr. Joule and Professor Thompson. By means of it we are enabled to present in a single line a series of facts which could not otherwise be expressed in many pages, and also to exhibit to the mind the connection of a series of phenomena which could not, without this aid, be definitely conceived. It is intimately connected with all branches of physical science, and, strange as it may appear, particularly with agriculture; and therefore we may be excused for presenting it in its broadest generalization, and with some considerable detail.

According to this theory, in its widest conception, every portion of the whole universe, or at least that part of it which is accessible to us by means of the telescope, is occupied by atoms inconceivably minute, hard, and unchangeable, separated from each other by attraction and repulsion. This assemblage of atoms constitutes the matter of the material universe; and the attractions and repulsions, the forces by which they are actuated, and to which is referable all the power or energy which produces the changes to which matter is subjected.

These atoms, thus endowed, form a plenum throughout all space, constituting what is called the ethereal medium, and in it, at wide intervals from each other, are isolated masses of grosser matter, which constitute our world, the planets, the sun, and stars. These also consist of atoms of another order, or of groups of atoms, with spaces between them, wide in comparison with the size of the atoms, and these spaces pervaded by the minuter atoms of the ethereal medium. These

bodies move in the medium without sensible resistance, or such as is only rendered evident by the minute retardation of the nebulous masses denominated comets.

According to this theory, the various isolated bodies of the universe act upon each other by means of the force of gravitation, and also by tremors or vibrations in this medium, radiating in every direction from each body as a centre.

The atoms of each kind of matter are separated by intervals; and before we proceed further, it will be necessary to consider more particularly this separation. It must be recollected that the hypothesis we are presenting is not the mere creature of the imagination, but formed upon a generalization of actual observation on the different states of grosser matter; therefore we will commence with the consideration, as an example, of the constitution of the air. This we assume to consist of atoms, each endowed with attracting and repelling forces. That these atoms are not in contact with each other, will be evident from the fact, that, if we apply a sufficient pressure to a quantity of air taken at its greatest known rarity, it may be compressed into at least one ten-thousandth part of its primitive volume. The sum of the magnitudes of the void spaces is therefore, in this case, at least ten thousand times greater than the sum of the material parts, whatever be their nature. In order to explain this, we are obliged to suppose that each atom is endowed with a repulsive force, similar to that possessed by one pole of a magnet for a similar pole of another magnet. And this repulsion increases with the diminution of distance between the atoms. It is feeble when the volume of air is expanded to its fullest extent, and exceedingly powerful when highly compressed. Whatever weight we may put on the top of a piston fitted to a cylinder filled with air will be sustained by the repulsion of the atoms. The piston will descend until each atom is brought precisely to that state of proximity to the next that the repulsive energy between the atoms just balances the weight on the piston, and thus the most delicate equipoise is afforded by the air. The slightest extraneous force is sufficient to disturb the equilibrium, which is again restored by a series of decreasing oscillations.

If the atoms of the air, however, are removed to a much greater distance, the repulsion entirely ceases, and attraction of gravitation takes its place. If it were not for this, the atmosphere would fly from the earth by the repulsive energy of its own atoms. We may, therefore, consider every atom of matter endowed with the property of obedience to the laws of force and motion; with inertia, by which it cannot change its place without the application of force, and, when in motion, cannot stop this motion without the application of an equal force in the opposite direction; and with attraction and repulsion, by which two atoms, placed at ever so great a distance from each other, will tend to approach each other with a force increasing inversely as the square of the distance. When these atoms approach very near to each other they would cease their motion, and if pressed nearer than this point would repel. And it appears, from experiment and observation, that there are several alternations of attraction and

repulsion, at distances, however, too minute for our senses, and only indicated by certain phenomena. Repulsion exists between the atoms of the densest bodies. Platinum, for example, which is 21 times heavier than water, and 257,000 times heavier than hydrogen, is still condensable. It may be compressed into a smaller space; and since the shrinking takes place equally in all directions, it follows that the atoms of this substance, as well as those of all gross matter, are not in contact. Indeed, when the hardest bodies are violently impelled against each other, and each is indented by the other, they do not come into actual mathematical contact, but are mutually impressed by the repulsive energy, which, vastly increased by the diminished distance, produces the visible effect.

All matter, therefore, is porous, whether in the liquid, gaseous, or solid condition. The pores may be conceived to be of different orders, namely: pores between the atoms, between the molecules or assemblages of atoms, and between the still larger particles. Gold itself is rendered brittle by being exposed to the fumes of sulphur, and solid iron is converted into steel by absorbing a large quantity of carbon, to which it owes that quality denominated temper.

In the case of atmospheric air and gases, the repulsive energy is alone exhibited in most of the mechanical phenomena, while in solid bodies both the attractive and repulsive are evident. Thus, if we place a heavy weight on the top of a vertical iron bar, its length will be diminished. If the weight be removed, the atoms, by repulsion, will spring back to their original distances; and this may be repeated any number of times with the same result, provided the weight is not so great as to cause any permanent change, which consists in a new arrangement of the atoms. If we now suspend the bar from one end, and apply a weight to the other, the bar will be elongated; and if the weight be removed, the atoms, by their attraction, will return to their normal position. In this state, the atoms are at the distance which constitutes a neutral condition. If pushed together, they fly apart whenever the compressing force is removed; and if drawn in the direction of the length of the body, they are brought into the region of attraction, and tend to bring the bar back to its original length when the elongative force is remitted.

This constitution of matter may be represented by a series of balls separated from each other by helical springs. If we attempt to elongate this bar, the springs will be drawn out. When we attempt to compress the mass, the several spires of the springs will be compressed closer together, and an action similar to repulsion will be produced.

This repulsion of the atoms is further demonstrated by the elasticity of a body, or the force with which it tends to restore itself to its former condition, when disturbed by any extraneous force. The elasticity, for instance, of a rod of tempered steel is exhibited when we bend it. It tends to return to its first form, in obedience to two forces. The atoms on the convex side, after the rod has been bent, are slightly separated, and are therefore in the region of attraction, while those on the concave side are brought nearer, and thus tend to

repel each other. If this be the case, there should be a line somewhere near the middle of the bent rod, in which the atoms are neither compressed nor dilated; and that such a neutral line does really exist can be shown by polarized light, which enables us, when the experiment is made on a rod of transparent glass, to look into the interior of the elastic body and observe the changes there produced.

The difference between the compressibilities of air and steel depends upon the difference in the repulsion of the atoms in the two cases. But in the latter, as well as in the former, there is the most delicate balance of forces; for, though a bar of good steel resists the weight of 60,000 pounds to the square inch, tending to separate it in the direction of its length, yet the atoms may be thrown into vibration by the minutest force; and this is the case with all solids. A single tap with the end of a penknife on the table of the large lecture room of the Smithsonian Institution is sufficient not only to throw into vibration every particle of air in the room, but also every particle of the solid parts of the edifice. The agitation of the air is proved by the sound, discernible in every part of the room, and the vibrations of the solid parts also, by the transmission of sonorous waves with even less loss than in the air.

The repulsion of which we have spoken, and which takes place only at minute distances, though these may be exceedingly great when measured by the size of the atoms, appears to be an essential endowment of matter, and is exhibited as well between the atoms of the ethereal medium as between those of air and other grosser assemblages of matter.

All bodies, as a general rule, are enlarged by an increase of temperature. But this result, as we shall endeavor to show, is not from an increase of the original repulsion, but from an energetic vibration imparted to the atoms, which tends to separate them and to produce the phenomena improperly ascribed to an imaginary fluid called heat.

We are obliged to assign to the ethereal medium a similar constitution to that possessed by grosser matter, namely, that it consists of inert atoms at great distances from each other relative to their own size, and each kept in position by attracting and repelling forces. Through this medium impulses or minute agitations are transmitted in celestial space, from planet to planet, and from system to system, and these tremors or waves constitute light, heat, and other emanations which we receive from the sun; or, in other words, the solar emanations are not matter, but motion communicated from atom to atom, beginning at the luminous body, and diffused in widening spherical surfaces, enlarging in size and diminishing in intensity, to the farthest portion of conceivable space.

The atoms of the ethereal medium are perfectly free to move in all directions, so that the earth and denser bodies experience no retardation as yet measurable; though lighter bodies, such as comets, apparently exhibit an effect of this kind, for the same reason that a stock of cotton is more retarded in falling through the air than a piece of lead. At first sight, it might appear paradoxical that atoms, which are kept in position by powerful attraction and repulsion, should yet

be perfectly movable among each other; but this condition is observed in liquid water, the particles of which, though they exhibit perfect mobility, yet repel and attract each other with immense force. This arises from the fact that every atom beneath the surface of a fluid is equally attracted and repelled on all sides by the surrounding atoms, and is, therefore, perfectly free to move. Not so, however, with the atoms at the surface; for they are attracted downwards without a counteracting force to attract them upwards, and hence great resistance is manifested when we attempt to separate them.

The author of this essay has shown, from conclusive experiments, that the attraction of water for water is as great as that of ice for ice, and the difference of the two conditions consists in the perfect mobility of the atoms of the former, and not in the neutralization of cohesion, as is generally supposed. If we attempt to draw up from the surface of water a circular disc of metal, say of an inch in diameter, we shall see that the water will adhere, and be supported several lines above the general surface. This adhesion, on account of the perfect mobility of the atoms, is due alone to the attraction of the atoms of the external film, and not to those of the whole mass which is elevated. This experiment, which is frequently given in elementary books as a measure of the feeble attraction of water for itself, is improperly interpreted. It merely indicates the force of attraction of a single film of atoms around the perpendicular surface, and not of the whole column elevated. The difference, then, of liquidity and solidity principally consists in the perfect mobility of the atoms.

The immobility of the atoms probably depends on their being assembled in larger groups, forming crystals, tissues, fibres, &c., and when force is applied to separate them, they all resist together. In breaking a piece of steel, for instance, by extension, all the parts throughout the cross section of the mass resist separation; and hence the great tenacity and rigidity of this substance; between which and pure water, other substances may be found having intermediate consistencies.

We have said that the atoms of the ethereal medium pervade those of all other bodies, and this assumption is analogous to the interpenetration of different bodies of different substances between the particles of each other.

If a piece of copper, plated with silver, be heated to redness, the latter metal will be absorbed into the former. Water absorbs a large portion of air, and between the atoms of the air itself there may exist an indefinite number of other gases. Melted silver poured into water gives out a large portion of oxygen, which it had previously absorbed from the air in its liquid state.

If we suppose solid bodies to be composed of a series of groups of atoms, the larger in succession formed from the smaller, the vacuity in all cases may far exceed the solidity.

Let us now consider more minutely the nature of the emanations from the sun—light, heat, &c.—in connection with the doctrine of atoms. And in order to this, we shall institute comparisons between the phenomena of light and heat, and those of sound, passing,

by analogy, from the palpable and well-known cause of familiar phenomena to that which is apparently not as readily accessible to our investigations, but which, when properly understood, is equally satisfactory in the explanation, prediction, and control of the phenomena.

Analogy of heat and sound.—If a heavy cannon be discharged at the distance of five or six miles, we shall see the flash almost instantaneously, and in about half a minute after the window will be violently agitated.

What is the cause of this agitation? No substance shot from the gun has reached us, for the same effect may be perceived on all sides. The simple and true explanation of the phenomenon is, that the atoms of air just around the mouth of the piece were, for an instant, violently pressed outwards by the blast of powder; these atoms were pressed against the next layer, and these against the next, and so on, until the impulse reached the distant window.

Each atom makes a short excursion or vibration, moving but little from its first position, and it is not, therefore, matter which proceeds from the cannon and produces the distant effect, but a propagation of motion from atom to atom.

The atoms are endued with inertia, and time is therefore required, even though immense force may be applied, to give them full motion. And, again, the atoms are not in contact, but are kept at a distance by repulsion, which increases when the atoms are pressed nearer each other. Hence, the second layer of atoms does not begin to move with full velocity at the precise moment when motion commences in the first.

The effect would be similar to that which would take place in a series of balls kept apart from each other by helical springs interposed. If a blow is given to the first ball, so as to drive it nearer to the second, the motion would not be instantaneously communicated; the second would resist a change of state, and would not move from its position until the spring was considerably bent. And in this way time would be required to propagate motion from the first ball to the second, from the second to the third, and so on, throughout the series.

If a series of lighter balls were substituted for the first, the springs remaining the same, it is evident the motion would be transmitted sooner, because the inertia would be in proportion to the weight of the balls. Hence, sound is transmitted more rapidly in lighter than in heavier gases; in hydrogen its velocity is greater than in carbonic acid.

Again: we may suppose the stiffness of the springs to vary, or, in other words, the repulsion between the atoms to become greater or smaller. If the springs become stiffer, then it is evident the motion will be transmitted sooner; for if the springs were infinitely rigid, or, what is the same, if a perfectly solid body were interposed between the balls, then the first ball could not move, without, at the same moment, giving motion to the last. Hence, if we increase the elasticity of a medium, and at the same time diminish the size of its atoms, any required velocity can be attained. Now, though the flash is appa-

rently perceived at the same instant at different places on the surface of the earth, yet we know, from the most satisfactory evidence, that this is really not the case, and that light and heat, as well as sound, require time for their propagation. Every impulse of the sun requires about eight minutes before it is felt at the distance of the earth.

The analogy between light and sound does not cease here, and to exhibit the resemblance still further, let us suppose a large bell placed in mid-air to be struck a single blow with a heavy hammer; we know that the lower rim of metal will be thrown into a state of vibration; it will be compressed into an elliptical form, the shorter axis in the direction of the blow. The elasticity will bring it back to its normal state, and will then carry it beyond in the other direction; and thus the part of the bell, for example, which is struck will continue to move backwards and forwards rapidly for a considerable time, which would be indefinitely prolonged were the experiment made in a perfect vacuum, and were no change produced in the atoms of the metal. In open air, however, the motion becomes feebler and feebler, and after a few minutes dies away and entirely ceases. The principal cause of this diminution is, evidently, the imparting of the motion of the metal to the immediately surrounding atoms of the air, and these to the next, and so on. It is evident that, at the moment that the rim of the bell is going from the spectator, a tendency to a vacuum would be produced, and the atoms of the first layer of air will follow the metal by their elasticity, and thus produce a rarefaction into which the atoms of the second layer of air will rush; and this will advance from layer to layer until it reaches the ear of the observer. But before it has got far on its way, the side of the bell will return, and will condense the air in contact with it, and send a positive impulse in the same direction with the first. These two impulses, travelling with equal velocities, and the one immediately succeeding the other, form an undulation.

The effect may be strikingly illustrated by water in a long trough. If a small block of wood of the width of the trough be suddenly drawn out of the liquid at one end of the trough, the water in immediate contact with the block will flow in to fill the vacuum; the water next will flow into the space thus left, and so on, a hollow or negative wave will be propagated from one end of the trough to the other. If the same block be suddenly thrust down into the water, the effect will be as if a quantity of water had been suddenly added. The liquid will rise at the side of the block, and in its fall another wave will be elevated outside of it, and so on, continually, a positive wave, or one of elevation, will be transmitted to the farther extremity of the reservoir.

If the two motions of the block be made, one immediately succeeding the other, a compound wave or an undulation will be the result. The transfer in this case is again that of form and not of substance. The atoms of water remain in place, as will be evident by placing bits of wood on the surface; they will rise and fall, but will not advance as the wave passes. This is an illustration of an undulation,

but not an exact representation of a sound wave, which consists in a slightly alternate backward and forward motion of each particle between the bell and the observer.

An undulation of sound, therefore, consists of two parts—a condensed and a rarefied part; and hence, when two series of undulations of the same wave length follow each other at a distance of half an undulation, they neutralize each other—the protuberance of the one undulation, as it were, exactly filling the hollow of the other; or, to express it more accurately, the rarefied and condensed parts of the two waves will neutralize each other, and in this way silence may be produced by two intense sounds. From analogy, therefore, if light also consists of waves, two series may be brought together, so as to produce darkness. Both these inferences are fully borne out by experiment.

Let us now consider the effect of the sound waves upon a distant object—such, for instance, as a delicate membrane stretched over a hoop and strewed with sand. We shall find that in the case of the sounding of an instrument at a distance, the sand will be violently agitated; and if the vibration is in unison with any of the strings of a neighboring piano, they will give forth an audible sound.

It may be well to stop one moment to inquire in what this unison consists. It is well known that a string of a given length performs all its vibrations in the same time. Now, if the impulses from the sounding body reach a string of such a time of vibration that the effect of the second impulse may be added to that of the first, or while the string is moving in the same direction as that given it by the first impulse, then the sounding will take place, or the string will be aroused into a motion harmonious with that of the sounding body. But if the impulses are not timed exactly to the vibrations of the string, they will meet the latter in its forward as well as in its backward movement, and thus tend to neutralize the effects of each other.

In the case of light and heat, the luminous or heated body is supposed to be in the condition of the bell during its sounding. The ethereal medium is the analogue of the air, and the vibrations of the optic nerve that of the tympanum of the ear.

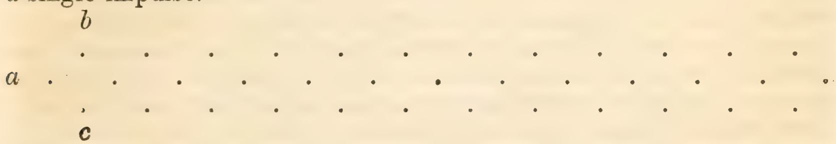
Further: in the case of heat, when the vibrations, for example, of the sun impinge upon the surfaces of solids and liquids, the ethereal medium within the interstices of these bodies, and also the atoms of gross matter, are put in a state of harmonious vibration, and thus give rise to the phenomena of the heat of temperature or expansion. When, as we have previously indicated, the vibrations of the atoms of solids become sufficiently violent to throw them beyond the sphere of cohesion, the matter is converted from a solid into a liquid, and finally into an aeriform condition.

But the question naturally arises, What is it that puts in vibration the luminous body—a candle, for instance—and keeps it for several hours in this constant state of agitation? The answer is, the continued rushing together of atom after atom of the carbon and hydrogen of the candle, and those of the oxygen of the surrounding air. Some

action of this kind, we must infer from analogy, is constantly producing, at the surface of the sun, impulses of a similar character.

From the analogies of light, heat, and sound, we might infer, since there are different lengths of waves of the latter, which give rise to the different notes of music, that there are different lengths of waves of the ethereal medium, producing different sensations in us and different effects upon gross matter. And this furnishes a ready explanation of the well-known phenomena of the different colors of the spectrum, and also of the less familiar but equally remarkable phenomena of the different kinds of radiant heat, as well as of the chemical and phosphorogenic emanations from the sun.

That there may be different forms of wave transmitted through the same medium will be evident from inspecting the following figure, and considering the motions of the atoms which may be produced by a single impulse.



If we strike, for example, the atom *a*, it will be driven towards the second atom, and the second towards the third, the third towards the fourth; and so on, the motion will be transmitted along the central line of atoms to the other extremity. But while this motion takes place through the centre line of the assemblage of atoms, the motion of *a* will also bring it nearer to the atoms *b* and *c*, on either side; and these will, therefore, be repelled from their positions of quiescence, and lateral waves, in which the atoms vibrate transversely to the direction of the ray, will be produced. It is probable that both kinds of vibration are transmitted through the ethereal medium, and perhaps also through the air; but such is the constitution of our eyes that we can only perceive the results of those of the second kind, and such the constitution of our ears that we can only take cognizance of those of the first. The transverse vibration of light and heat was a happy conception of Dr. Thomas Young, one of the discoverers of the key to the Egyptian hieroglyphics, and was applied by himself and Fresnel to the explanation of a large and interesting series of facts classed under the name of polarization of light and heat.

Besides the invisible emanation from the sun, which gives us the sensation of heat, there are others equally invisible which produce other effects. Indeed, it is possible that there are an indefinite number of waves, differing in length and perhaps in form, though many of these must be so minute as to produce no appreciable physical effect at the distance of our planet. If a beam of light be decomposed by a prism, it is well known that it will be separated into parts, producing different colors. Now, if we subject to this spectrum, a piece of paper which has been soaked in a solution of nitrate of silver, we shall find that the salt of silver will be decomposed, and the paper will be blackened by the reduced metal. But the interesting part of the experiment is, that the blackening will be more intense at a point

in the prolongation of the spectrum, which is entirely in the dark. There is, then, in a sunbeam, besides light and heat, a ray which may be separated from the former by a prism, which produces chemical decomposition, and is hence called the chemical ray. I need scarcely remark that it is this ray, and not that of light, which produces the picture in the photographic and daguerrean processes.

Again: it is well known that, if we expose for an instant a diamond to the rays of the sun, and then convey it to a dark place, we will see it glow with a pale phosphorescent light; but this effect, long familiar as it has been to the natural philosopher, is now known to be the result of an emanation differing in some essential particulars from all the other emanations which we have mentioned. To prove this, it is sufficient to place the diamond under a plate of transparent mica, a substance which transmits freely light, heat, and the chemical emanation. This will screen the diamond; and the glowing, which was before very striking, will not now be produced. That this effect is not the result of the absorption of a ray of light will be evident when we mention the fact that a diamond will glow when placed under a thick plate of smoky quartz, which intercepts both light and chemical emanation, but freely transmits what is denominated the phosphorogenic ray. These results are all in accordance, in a general way, with the constitution of the ethereal medium which we have presented.

Light and heat appear to differ only in the lengths of the waves, which become shorter and more intense as the temperature of the source of emanation increases; though in some cases, as in that of liminous phosphorus and the light of the glow worm, it is emitted freely from bodies of low temperature. It is possible that light from these different sources may possess different physical properties.

Electricity.—The phenomena of light, of heat, of the chemical and phosphorogenic emanations, have all been referred to vibrations of the ethereal medium, and all the facts which have thus far been observed are in accordance with this generalization. The question, however, naturally arises as to what explanation we can give of the multiplied and various phenomena which are constantly presenting themselves to us in connection with all the changes which are taking place around us in Nature, or which exhibit themselves to the chemist and physicist in their investigations of the minuter reactions which are brought about by their agency, and which are classed under the general term of electricity. It is a recognized principle of philosophy to adopt no other causes for the explanation of phenomena than are true and sufficient; and although the existence of the ethereal medium may by some be doubted, yet to me it appears as certain as any fact can be which rests upon influences drawn from observed phenomena. The wave motions which we refer to it, and which exactly agree with the observed facts, are precisely such as are produced in gross matter under the action of the laws of force and motion, and therefore we have nearly the same reason for believing in the existence of this diffused substance as in that of gross matter itself. Besides, the tendency of science is to reduce rather than increase the number of

agencies to which effects are referred as causes. We shall, therefore, assume that the ethereal medium is also the agent by which the phenomena of electricity are produced; but the facts classed under the head of electricity cannot be explained on the principle of wave motions, and we must therefore seek for some other probable mechanical action from which they may be rationally deduced.

Electrical phenomena may be referred to two great classes, statical and dynamical, or such as appear to be produced by the repulsive action of a fluid at rest, and by the same fluid in a state of motion. In some cases, we have action at a distance on surrounding bodies which develop new and permanent properties so long as the conditions remain the same; and in other cases effects, which exactly resemble those of a transfer—not of a property, but of actual substance, from one body to the other. Now, these phenomena may be referred to an accumulation of the ethereal medium in one portion of space, and a corresponding diminution in the adjacent space around. If the particles of the ethereal medium, when thus accumulated, act at a distance on other portions of the same medium, we shall have a rational exposition of the phenomena of statical electricity; and in the restoration of the equilibrium of the medium, or in its return to its normal condition, we have a plausible cause of the dynamic effects belonging to the same class. But how is this disturbance of the equilibrium of the ethereal medium produced? The answer is, by the agency of gross matter. From the refraction of of light and the various effects of heat, we must infer that the ethereal medium is intimately connected with gross matter; and although the latter may move in it without disturbing the equilibrium, yet when two pieces of gross matter are rubbed together, an accumulation of the atoms of the ethereal medium may take place on the one, and a deficiency in the other. According to this view, there can be no electrical excitement in celestial space; for there gross matter does not exist, without which the medium cannot be coerced or the equilibrium disturbed. It is not supposed, in accordance with this hypothesis, that there is an absolute vacuum produced in the medium, but that a condensation exists in a given spot, and a corresponding rarefaction in the space around it. The degree of this condensation and rarefaction may be exceedingly slight, in comparison with the whole elastic force of the medium, and therefore it is not essential to the truth of the hypothesis that any very perceptible changes should be produced in rays of light passing in close approximation to electrified bodies.

This hypothesis is adapted to the theory of either one or two fluids. In the second case, the ethereal medium must be supposed to consist of two kinds of atoms, the separation of which gives rise to the phenomena observed; and in the first, that it consists of but one kind of atom, and that the effects observed are due to its being in excess in one body, and in deficiency, at the same time, in another.

In a new investigation of the discharge of a Leyden jar, by the author of this essay, the facts clearly indicated the transfer of a fluid from the inside to the outside, and a rebound back and forward

several times in succession, until the equilibrium was attained by a series of diminishing oscillations.

The magnetic phenomena may be referred to an assemblage of electrical currents, according to the theory of Ampère, or to a peculiar arrangement of the ethereal atoms within the magnetic body.

The electro-magnetic phenomena appear to be due to the action of the atoms of gross matter combined with that of the ethereal medium.

We cannot, in this place, go into an exposition of the facts of electricity and magnetism, but will merely point out one inference from the hypothesis we have given, that electricity is not in itself a primary source of motion or mechanical energy, tending to produce change by a kind of spontaneity, as is frequently supposed, but the effect of a disturbance and subsequent restoration of an equilibrium, which disturbance has been produced by the application of an extraneous force. This conclusion may also be arrived at, without reference to the hypothesis, from the study of the facts themselves, which clearly demonstrate that the electrical equilibrium, whatever may be its nature, is never disturbed by its own action, but the disturbance is always the effect of the application of some other power, and is the mechanical equivalent of such disturbing cause.

Crystalline forms.—We will now consider the grouping of the atoms, which is intimately connected with the various properties of different kinds of bodies. When the atoms of gross matter are suffered to approach each other, without disturbance or agitation, and, from an aeriform or liquid condition, gradually to assume the solid form, they exhibit beautiful geometrical figures, familiarly known under the name of crystals. For example, if a quantity of common salt be dissolved in water, and the liquid be suffered to evaporate in a still place, beautiful crystals of a cubical form will be found in the vessel; or, if ordinary saltpetre be dissolved in warm water and suffered to cool, regular six-sided crystals will be obtained. If these crystals be reduced to an impalpable powder, and again dissolved in hot water, the same result will again be produced, provided the liquid be not in excess.

The most interesting illustration of crystallography to the meteorologist is that exhibited in snow and hoar frost. These generally consist of stellar figures in one plane, with rays and branches of rays, all making angles of 60° with each other, and, under different conditions of the atmosphere, are exceedingly varied and beautiful. To explain these figures in a general way, let us suppose three separate atoms to be within the sphere of mutual attraction and free to move; they will approach until they come within the sphere of repulsion, and will then evidently be found in the same plane at the angular points of an equilateral triangle, since each must be at the same distance from each of the other two. If a fourth atom be suffered to approach in the same manner, it will, also, arrange itself at an equal distance from each of the three others at the apex of a regular triangular pyramid of equal and similar faces. The next symmetrical arrangement which could take place would be in case a fifth atom were added; and if this were situated on the other side of the base of the

pyramid, a regular six-sided figure would result. We see, from these examples, that regular geometrical forms are the necessary effect of the undisturbed grouping of the atoms, though it is impossible to deduce all the facts from considerations as simple as those we have given above. To adapt the hypothesis to the facts of the case, we are obliged to assume that crystalline forms are not the result of the approximations of single atoms, but of molecules of more or less complicated structure.

Though the exact representation of the groupings of particles of different kinds of matter has exercised the ingenuity of a number of investigators, the subject is still in a very imperfect condition. It offers, however, a rich harvest for scientific culture, and a number of interesting conclusions have been deduced from the crystallographic study of bodies, particularly by M. Gaudin. We are obliged to suppose that the primary molecules which enter into crystals are themselves of a geometrical shape, due to the arrangement of the ultimate atoms of which they are composed, and such forms are called the primitive forms of the crystalline molecules. These primitive molecules vary in form and size, as we shall see hereafter, and they vary also in these respects, in some cases, of their combinations. If the two salts we mentioned in the commencement of this division of our subject—namely, saltpetre and common salt—be dissolved together in a sufficient quantity of water, and the liquid be suffered gradually to evaporate, they will be found at the bottom of the vessel in separate crystals. The cubes of common salt can readily be distinguished from the long-sided prisms of saltpetre, and when these are chemically analyzed, each is found to be exclusively composed of its respective substance. Not a single atom of the saltpetre is found in the crystal of salt, nor one of the latter in the former. The same effect takes place if magnesia and saltpetre be dissolved in hot water and the solution be suffered to cool. The case, however, is altogether different when sulphate of magnesia, and sulphate of nickel or sulphate of zinc are crystallized together, from the same solution. The separation of the two substances, as in the former instance, does not take place—the individual crystals formed will contain both sulphate of zinc and sulphate of magnesia, or sulphate of nickel and sulphate of magnesia, and this in every possible proportion, according to the relative amounts of the two salts in solution. Now, if we compare a crystal of sulphate of magnesia with a crystal of sulphate of nickel, we find they have identically the same crystalline form. There is no perceptible difference in their angles, edges, or solid angles. Now, since a large crystal is built up of an aggregation of small ones of the same form, it is evident that the primitive molecule of sulphate of nickel must have the same form as that of the sulphate of magnesia; and, therefore, that in forming in a large crystal they may be mingled together in the way we have just described, provided they are of the same size, or perhaps some multiple of the same size, for it is evident that it would be impossible to build a wall of symmetrical structure with bricks of different angular forms and sizes, since the parts would not fit or exactly fill the spaces. We must therefore conclude, that though the ultimate atoms of bodies may be spherical, the

groupings of them, which form the primitive crystallizing molecules, are of different geometrical shapes and sizes.

The atomic weights or combining proportions.—Though the primordial atoms may all be of the same weight and size, and the different kinds of matter the result of the different forms in which they are grouped, yet in the present state of science there are sixty-one substances which are classed by the chemist as simple bodies, and which must continue thus to be classed until they shall be actually decomposed into two or more separate components. If these bodies consist of elementary atoms, or of groups of atoms, always of the same number and form, it will follow that all combinations of them will take place in definite and fixed proportions. For example, it is known that one part of hydrogen by weight unites with eight parts of oxygen to form water, and this liquid, whenever found, always contains the same proportion of these ingredients. But there is another compound of oxygen and hydrogen, of which the components are in the ratio of one to sixteen, and this result is precisely that which might have been anticipated from the theory of atomic combination. In the first case, if the atom of hydrogen weigh one, for instance, $\frac{1}{1000000}$th of a grain, and the atoms of oxygen $\frac{8}{1000000}$ths, then any amount of combination will have the same proportion. The combinations then will be one to eight, one to sixteen, and if another combination of oxygen and hydrogen exist, it will be in the ratio of one to twenty-four. In the first instance, it is one atom to one; in the next, of one atom to two; in the third case, would be one atom to three. This is also beautifully shown in the union of oxygen and nitrogen, of which there are five different compounds, as exhibited in the accompanying table.

NAMES OF COMPOUNDS.	Weight.		Ratio.	
	N.	O.	N.	O.
Protoxide of nitrogen	14	8	1	1
Binoxide of nitrogen	14	16	1	2
Hyponitrous acid	14	24	1	3
Nitrous acid	14	32	1	4
Nitric acid	14	40	1	5

A glance at this table will show the justice of the remark of M. Dumas, that, granting matter to be atomic, it must necessarily combine as it is found to do in this instance. We refer to any work on chemistry for a table of atomic weights, and shall only give here those of the atoms which form the principal part of animal and vegetable bodies, namely: hydrogen, carbon, oxygen, and nitrogen:

	Atomic weight.
Hydrogen	1
Carbon	6
Oxygen	8
Nitrogen	14

To these, in lesser quantities, are added sulphur, 16; phosphorus, 32. We may say, therefore, that the whole atomic system of animal and vegetable physiology depends principally on the four numbers 1, 6, 7, 8. Wherever the substances above mentioned are found in combination in any of the three kingdoms of Nature, they always combine according to these numbers, or multiples of them—a statement which contains in a single line a truth of the widest significance; which has rendered chemistry an almost mathematical science, and its applications to agriculture an art of the highest value and of comparatively easy attainment. To facilitate still more the use of this generalization, the atoms are expressed in abbreviated language. Thus water is represented by HO—that is, one atom of hydrogen, 1, and one of oxygen, 8, making nine for the weight of the liquid. Two atoms of water would be represented by 2 HO; carbonic acid by CO_2, or one atom of carbon, 6, and two atoms of oxygen, 16; making for the atomic weight of the acid 22. Nitric acid is represented by NO_5, and ammonia by NH_3, and nitrate of ammonia by $NO_5 + NH_3$; indicating, in the formation of nitric acid, five atoms of oxygen and one atom of nitrogen, and in that of ammonia, three atoms of hydrogen to one of nitrogen. The attainment of a knowledge of this notation is easy, while the use of it is exceedingly convenient.

Atomic volumes.—The spheres of repulsion of different chemical atoms, or rather molecules, are probably different; and as we may consider these spheres as constituting the size of the atoms, in reference to the space which they occupy in combination, their magnitudes may be calculated with a view to ascertain whether any similarity can be found in the properties and action of bodies having equal atomic volumes. To explain how this may be done, let us suppose we wish to know the number of atoms in a given volume of matter of which the whole weight is known, and also the weight of a single atom; we shall then evidently have the required number of atoms by dividing the weight of the one atom into the weight of the whole. Now, if we know the number of atoms in a body of given size, we can find the size of each atom by dividing the bulk of the whole by the number of atoms; but since we can only ascertain relative atomic weights and volumes, we suppose the volume of the mass to be unity, and the weight of the same to be the specific gravity, or weight relatively to that of water. If we then divide the atomic weight into the specific gravity, we shall have the relative number of atoms; and if we divide this number into 1, or, what is the same thing, invert the fraction and divide the atomic weight by the specific gravity, we shall have the relative atomic volume. We find in this way that there are groups of simple bodies having nearly the same atomic volume, and that, when crystallized in the same form, one may be substituted for the other, giving rise to compounds of similar forms, and in some cases of similar properties, though of different chemical constitution; and, on the other hand, by the differences in the grouping of the same atoms, bodies may be formed having entirely, difirent properties.

It frequently happens that, in the union of different bodies in the

gaseous state, a condensation takes place, and the volume of the compound molecule is not equal to the sum of the volumes of atoms of which it is composed; and in other cases the reverse effect has place, and an expansion is the result.

The following table, from Faraday's lectures, exhibits the combination of volumes to illustrate this subject. In this the volume of nitrogen, N, is considered as unity, and that of oxygen as half unity:

Table showing the volumes of elements in various nitrogen compounds, and the difference in quality, effected by combination.

N	
N O	Gas, inodorous, sweet, inactive.
N O O O O O O	Liquid, acid, colorless, corrosive.
N O O	Gas, colorless, not acid, insoluble, oxidizing.
N O O O O	Gas or liquid, colored, acid, soluble.
N O O O	Liquid, acid, unstable.
N H H H	Gas, alkaline. (Nitrogen and hydrogen.)
N C C C	Liquid, detonating. (Nitrogen and carbon.)
N I I I	Solid, detonating. (Nitrogen and iodine.)
N C C	Gas, combustible, odorous, poisonous.

One of the peculiarities of the chemical combination of bodies is the neutralization, in a greater or less degree, of their attractions. Thus, sulphuric acid and quick-lime, which have a powerful attraction for other substances, and therefore highly corrosive, when united, form plaster of Paris—a neutral, inert substance. An analogous result takes place when the north and south poles of two magnets of equal power are brought into contact; if they are not of equal power, a residual action will be left in one. In a similar manner, two

glass balls, electrified, the one plus and the other minus, both, when separate, attract the surrounding objects; but when brought into proximity, they rush into contact, and neutralize one another's attraction. This fact distinguishes chemical attraction from the attraction of gravitation, in which there is no neutralization of this kind, and refers the former to that condition of the ethereal medium called electric, in which it probably exists in strata of different densities around each separate molecule. The facts in reference to this point have been classed under the head of electro-chemistry; and in this case, as in every other subdivision of our general subject, we have merely indicated a group of phenomena, each of which has occupied the attention of a number of scientists, and in some cases during a term of years.

Until recently it was supposed that the physical qualities of bodies must depend on the nature of their elements, or, in other words, upon their chemical composition; but a great many substances have been discovered, composed of the same elements in the same relative proportion, and yet exhibiting physical and chemical properties entirely distinct one from the other. For example, according to Liebig, the oil of turpentine, the essence of lemon, oil of balsam of copaiba, oil of rosemary, oil of juniper, and many others differing widely from each other in their odor, in their medicinal effects, in their boiling points, in their specific gravities, all contain the same elements, carbon and hydrogen, and in precisely the same proportion. The crystallized part of the oil of roses, a volatile solid, of which the delicious fragrance is so highly esteemed, is a compound body, containing exactly the same elements and in the same proportions as the gas employed in lighting our streets.

Such bodies are called *isomeric*—literally, *equal parts*—and the phenomena are classed under the head of isomerism. These remarkable facts can only be accounted for by the different groupings of the atoms. They exhibit, as it were, the economy of Nature in producing the most multiform effects from combinations of the simplest principles, and almost revive in us the dreams of the alchemists relative to the transmutation of matter.

Combinations of this kind are generally of a very unstable character, and the atoms can sometimes be made to change their positions by an impulse from without, or by the addition of heat, and to combine again, forming other substances having entirely different properties.

The changes we have mentioned are those of bodies which are formed of groups of many chemical atoms; but a fact of a similar character has been observed with reference to bodies belonging to the class which the chemist calls simple or elementary, because they have not as yet been decomposed. Of these bodies, we may mention oxygen, chlorine, sulphur, and phosphorus. They all assume, under certain conditions, entirely different properties to such an extent as almost to lose their identity. Oxygen, when exposed to a series of sparks of electricity, is converted into a substance called ozone, of which we shall speak more fully hereafter. Sulphur, exposed to a

temperature of 226° F., is melted, and if maintained in fusion at a temperature not exceeding 300°, and then suddenly thrown into water, will be found to have suffered no change; if, however, the fusion be continued above 300°, the material becomes black and almost solid; and if it now be poured into water, it maintains its dark color, and assumes a consistence of heated glue or softened India rubber. In this condition its medical and other properties are changed. Sulphur is also capable of assuming two different crystalline forms belonging to two primitive classes entirely distinct. Phosphorus undergoes a similar change, and chlorine, after exposure to the light, exhibits new properties. Phenomena of this kind are classed under the head of *allotropism.*

Organic molecules.—The groups of atoms which we have thus far been considering, are principally those which have been formed under the influence of what is called the chemical force, and result from the ordinary attraction of the atoms. These are comparatively simple groups; but there is another class of groups of atoms of a much more complex character, and which are formed of new combinations of the ordinary atoms under the influence or, we may say, direction of that mysterious principle called the *vital force.* We are able to construct a crystal of alum from its elements by combining sulphur, oxygen, hydrogen, potassium, and aluminum; but the chemist has not yet been found who can make an atom of sugar from the elements of which it is composed. He can readily decompose it into its constituents, but it is impossible so to arrange the atoms artificially, as in the ordinary cases of chemical manipulation, to produce a substance in any respect similar to sugar. When the attempt is made, the atoms arrange themselves spontaneously into a greater number of simpler and smaller groups or molecules than is found in sugar, which is composed of molecules of high order, each containing no less than 34 atoms of carbon, oxygen, and hydrogen.

The organic molecules, or atoms, as they are called, are built up under the influence of the vital principle of inferior groups of simple elements. These organic molecules are first produced in the leaves of the plant under the influence of light, and subsequently go through various changes in connection with the vital process. After they are once formed in this way, they may be combined and recombined by different processes in the laboratory, and a great variety of new compounds artificially produced from them.

But what is this vital principle, which thus transcends the sagacity of the chemist and produces groups of atoms of a complexity far exceeding his present skill? It is generally known under the name of the vital *force;* but since the compounds which are produced under its influence are subject to the same laws, though differing in complexity, as those produced by the ordinary chemical forces; and since in passing from an unstable to a more stable condition in the form of smaller groups, they exhibit, as will be rendered highly probable hereafter, an energy just equivalent to the power exerted by the sunbeam, under whose influence they are produced, it is more rational to suppose that they are the result of the ordinary chemical forces acting

under the *direction* of what we prefer to call the vital *principle.* This is certainly not a *force*, in the ordinary acceptation of the term, or in that in which we confine this expression to the attractions and repulsions with which material atoms appear to be primarily endowed. It does not act in accordance with the restricted and uniform laws which govern the forces of inert matter, but with forethought, making provision far in advance of a present condition for the future development of organs of sight, of hearing, of reproduction, and of all the varied parts which constitute the ingenious machinery of a living being. Matter without the vital influence may be compared in its condition to steam which, undirected, is suffered to expend its power in producing mechanical effects on the air and other adjacent bodies, marked with no special indications of design; while matter under its influence may be likened to steam under the directing superintendence of an engineer, which is made to construct complex machinery and to perform other work indicative of a directing intelligence. *Vitality*, thus viewed, gives startling evidence of the immediate presence of a direct, divine and spiritual essence, operating with the ordinary forces of Nature, but being in itself entirely distinct from them.

This view of the subject is absolutely necessary in carrying out the mechanical theory of the equivalency of heat and the correlation of the ordinary physical forces. Among the latter, vitality has no place, and knows no subjection to the laws by which they are governed.

All the constituents of organic bodies are formed of organic molecules, and, as we have said, these are of great complexity, and are readily disturbed and resolved into a greater number of lesser groups. Thus, the constitution of cane sugar is represented by C_{12}, H_{11}, O_{11}, making in all 34 atoms. Organic bodies are, therefore, in what may be called a state of power, or of tottering equilibrium, like a stone poised on a pillar, which the slightest jar will overturn; they are ready to rush into closer union with the least disturbing force. In this simple fact is the explanation of the whole phenomena of fermentation, and of the effect produced by yeast and other bodies, which, being themselves in a state of change, overturn the unstable equilibrium of the organic molecules, and resolve them into other and more stable compounds. Fermentation, then, simply consists in the running down from one stage to another of organic molecules, changing their constitution, and at last arriving at a neutral state. There is, however, one fact in connection with the running down of the organic molecules which deserves particular attention, namely, that it must always be accompanied with the exhibition of power or energy, with a disturbance of the ethereal equilibrium in the form of heat, sometimes even of light, or perhaps of the chemical force, or of that of the nervous energy, in whatever form of motion the latter may consist. It is a general truth of the highest importance in the study of the phenomena of Nature, that whenever two atoms enter into more intimate union, heat, or some form of motive power, is always generated. It may, however, be again immediately expended in effecting

a change in the surrounding matter, or it may be exhibited in the form of one of the radiant emanations.

Balance of Nature.—The term balance of organic nature was first applied, we think, by Dumas, to express the relations between matter forming animals and vegetables, and the same matter in an inert condition. We shall apply the term "balance of nature," in a more extended sense, and include within it the balance of power, as well as the transformations of matter. The amount of matter in the visible universe is supposed to remain the same, though it is subject to various transformations, and appears under various forms—now built up into organic molecules, and now again resolved into the simple inorganic compounds. The carbon and other materials absorbed from the air by the plant is given back to the atmosphere by the decaying organisms, and thus what may be called a constant balance is preserved. But this balance, if we may so call it, does not alone pertain to the matter, but also to the energy which is employed in producing these changes. It may disappear for a while, or may be locked up in the plant or the animal, but is again destined to appear in another form, and to exert its effects, perhaps in distant parts of celestial space.

To give precision to our thoughts on this subject, let us suppose that all the vegetable and animal matter which now forms a thin pellicle at the surface of the earth were removed—that nothing remained but the germs of future organisms buried in the soil and ready to be developed when the proper influences were brought to bear upon them. Let us further suppose the sun to cease giving emanations of any kind into space. The radiation from the earth, uncompensated by impulses from the sun, would soon reduce the temperature of every part of the surface to at least 60° below zero; all the matter and liquid substances capable of being frozen would be reduced to a solid state; the air would cease to move, and universal stillness and silence would prevail.

Let us now suppose that the sun were to give forth rays of heat alone; these would radiate in every direction from the celestial orb, and an exceedingly small portion of them, in comparison with the whole, would impinge against the surface of our distant planet, would melt the ice first on the equator, then on the more northern and southern parts of the globe, and, finally, their genial influence would be felt at the poles. The air would be unequally rarefied in the different zones, the winds would again be called forth, vapor would rise from the ocean, clouds would be formed, rain would descend, and storms and tempests would resume their sway.

If the sun should again intermit its radiation, all these motions would gradually diminish, and after a time entirely cease; the heat given to the earth would, in part, be retained for awhile, but in time would be expended; the water would slowly give out its latent caloric and be again converted into ice. Something of this kind takes place in the northern and southern parts of the earth during the different periods of summer and winter. Since the mean temperature of the earth does not vary from year to year, it follows that all the excess of heat of summer received from the sun is given off in winter, and

hence the impulses from this luminary which constitute all the energy, producing the changes on the surface of the earth, merely lingering for awhile, are again sent forth into celestial space, changed, it may be, in form, but not in the amount of their power. The solar vibrations have lost none of their energy, for the water has returned to the state of ice, and the surface of the earth is again in the same condition in which it was before it received the solar impulse. The energy of the solar vibrations communicated to the ice overcomes its cohesion, converting it into the liquid state, and the ice again becoming solid gives out the same amount of heat in a less energetic form. Even the motive power of the wind is expended by the friction of its particles in producing an amount of heat equivalent to that which gave rise to its motion, and this also is radiated into celestial space.

But the most interesting part of our inquiry relates to the effects which the radiation alone of heat from the sun would have on the vegetable germs buried in the soil. If these germs were enclosed in sacs filled with starch and other organic ingredients, stored away for the future use of the young plant, as in the case of the tuber of the potato, or the fleshy part of the bean, as soon as the sun penetrated beneath the surface in sufficient degree to give mobility to the complex organic molecules of which these materials consist, the proper degree of moisture also supposed to be present, germination would commence. The young plant would begin to be developed, would strike a rootlet downward into the earth, and elevate a stem towards the surface furnished with incipient leaves. The growth would continue until all the organic matter in the tuber or sac was exhausted; the further development of the plant would then cease, and in a short time decay would commence.

But let us dwell a few minutes longer on the condition of the plant and the tuber before the downward action becomes the subject of consideration. If we examine the condition of the potato which was buried in the earth, we shall find remaining of it nothing but the skin, which will probably contain a portion of water. What has become of the starch and other matter which originally filled this large sac? If we examine the soil which surrounded the potato, we do not find that the starch has been absorbed by it; and the answer which will, therefore, naturally be suggested is, that it has been transformed into the material of the new plant, and it was for this purpose originally stored away. But this, though in part correct, is not the whole truth; for if we weigh a potato prior to germination, and weigh the young plant afterwards, we shall find that the amount of organic matter contained in the latter is but a fraction of that which was originally contained in the former. We can account in this way for the disappearance of a *part* of the contents of the sac, which has evidently formed the pabulum of the young plant. But here we may stop to ask another question: By what power was the young plant built up of the molecules of starch? The answer would probably be, by the exertion of the vital force; but we have endeavored to show that vitality is a *directing principle*, and not a mechanical power, the expenditure of which does work. The conclusion to which we

would arrive will probably now be anticipated. The portion of the organic molecules of the starch, &c., of the tuber, as yet unaccounted for, has run down into inorganic matter, or has entered again into combination with the oxygen of the air, and in this running down, and union with the oxygen, has evolved the power necessary to the organization of the new plant.

If we examine the skin of a potato, we shall find it perforated by innumerable holes, through which the oxygen penetrates into the interior to enter into combination with the starch; or, in other words, to burn it by a slow combustion, and through which the carbonic acid and vapor of water again find their way into the atmosphere. We see from this view that the starch and nitrogenous materials, in which the germs of plants are imbedded, have two functions to fulfil—the one to supply the pabulum of the new plant, and the other to furnish the power by which the transformation is effected, the latter being as essential as the former. In the erection of a house, the application of mechanical power is required as much as a supply of ponderable materials.

But to return to our first supposition. We have said (and the assertion is in accordance with accurate observation) that the plant would cease to increase in weight under the mere influence of heat, however long continued, after the tuber was exhausted. Some slight changes might, indeed, take place; a small portion of pabulum might be absorbed from the earth; or one part of the plant might commence to decay, and thus furnish nourishment to the remaining parts; but changes of this kind would be minute, and the plant, under the influence of heat alone, would, in a short time, cease to exist.

Let us next suppose the sun to commence emitting rays of *light*, in addition to those of heat. These, impinging against the earth, would probably produce some effects of a physical character; but what these effects would be we are unable, at the present time, fully to say. We infer, however, that the light, not immediately reflected into space, would be annihilated; but this could not take place without communicating motion to other matter. It would probably be transformed into waves of heat of feeble intensity.

Let us now suppose, in addition to heat and light, the chemical rays to be sent forth from the sun. These would also produce various physical changes, the most remarkable of which would be in regard to the plant.

The carbonic acid of the atmosphere, in contact with the expanding surface of the young leaves, would be absorbed by the water in their pores, and in this condition would be decomposed by the vibrating impulses which constitute the chemical emanation. The atoms of carbon and oxygen, of which the carbonic acid is composed, would be forcibly separated; the atoms of oxygen would be liberated in the form of gas, and the carbon be absorbed to build up, under the directing influence of vitality, the woody structure of the plant. In this condition the pabulum of the plant is principally furnished by the carbonic acid of the air, while the impulses of the chemical ray furnish the primary power by which the decomposition and the other

changes are effected. This is the general form of the process, leaving out of view minute changes, actions and reactions, which must take place in the course of organization.

All the material of which a tree is built up, with the exception of that comparatively small portion which remains after it has been burnt, and constitutes the ash, is derived from the atmosphere. That this is so, can be proved by growing a plant in perfectly pure flint sand, to which a minute quantity of foreign substance is added, and sprinkling with distilled water. In this case, the plant will yield the usual amount of carbon or charcoal, although there was none in the soil in which it grew.

In the decomposition of the carbonic acid by the chemical ray, a definite amount of power is expended, and this remains, as it were, locked up in the plant so long as it continues to grow; but when it has reached its term of months or years, and some condition has been introduced which interferes with the balance of forces, then a reverse process commences, the plant begins to decay, the complex organic molecules begin to run down into simpler groups, and then again into carbonic acid and water. The materials of the plant fall back into the same combinations from which they were originally drawn, and the solid carbon is returned in the form of a gas to the atmosphere, whence it was taken. Now, the power which is given out in the whole descent, is, according to the dynamic theory, just equivalent to the power expended by the impulse from the sun in elevating the atoms to the unstable condition of the organic molecules. If this power is given out in the form of vibrations of the ethereal medium constituting heat, it will not be appreciable in the ordinary decay, say of a tree, extending, as it may, through several years; but if the process be rapid, as in the case of combustion of wood, then the same amount of power will be given out in the energetic form of heat of high intensity. This heat will again radiate from the earth; and in this case, as in that we have previously considered, the impulse from the sun merely lingers for a while upon the earth, and is then given back to celestial space, changed in form, but undiminished in quantity. It may continue its radiating course through stellar space, until it meets planets of other systems; but to attempt to trace it further would be to transcend the limits of inductive reason, and to enter those of unbridled fancy.

In the process we have described, the carbon, hydrogen, and other substances which are absorbed from the atmosphere, are returned to this great reservoir to be used again, and, it may be, to undergo the same changes many times in succession. The earthy materials are again returned to the earth, and all the conditions, as far as the individual plant which we are considering is concerned, are the same as they were at the beginning. The absorption of power in the decomposition of the carbonic acid gas, and its evolution again when the recomposition is produced of the same atoms, is precisely analogous to that which takes place in forcibly separating the poles of two magnets, retaining them apart for a certain time, and suffering them to return by their attractive force to their former union. The energy

developed in the approach of the magnets towards each other is just equal to the force expended in their separation.

By extending this reasoning to the vast beds of coal which are stored away in the earth, we are brought irresistibly to the conclusion that the power which is evolved in the combustion of this material, now so valuable an agent in the processes of manufacture and locomotion, is merely the equivalent of the force which was expended in decomposing the carbonic acid which furnished the carbon of the primeval forests of the globe; and that the power thus stored away millions of years before the existence of man, like other preordinations of Divine Intelligence, is now employed in adding to the comforts and advancing the physical and intellectual well-being of our race.

In the germination of the plant a part of the organized molecules runs down into carbonic acid to furnish power for the new arrangement of the other portion. In this process no extraneous force is required; the seed contains within itself the power and the material for the growth of the new plant up to a certain stage of its development. Germination can, therefore, be carried on in the dark, and, indeed, the chemical ray which accompanies light retards rather than accelerates the process. Its office is to separate the atoms of carbon from those of oxygen in the decomposition of the carbonic acid, while that of the power within the plant results from the combination of these same elements. The forces are therefore antagonistic, and hence germination is more rapid when light is excluded; an inference borne out by actual experiment.

Animal Organism.—Besides plants, there is another great class of organized beings, viz: animals; and as we commenced with the consideration of the seed in the first case, let us begin in this with the egg. This, as is well known, consists of a sack or shell containing a mass of organized molecules formed of the same elements of which the plant is composed, viz: carbon, hydrogen, oxygen, and nitrogen, with a minute portion of sulphur and other substances. Indeed, this material is derived exclusively from the animal kingdom. Without attempting to describe the various transformations which take place among these organized molecules, a task which far transcends our knowledge or even that of the science of the day, we shall merely consider the general changes which occur of a physical character.

As in the case of the seed of the plant, we presume that the germ of the future animal pre-exists in the egg, and that by subjecting the mass to a degree of temperature sufficient perhaps to give greater mobility to the molecules, a process similar in its general effect to that of the germination of the seed commences. Oxygen is absorbed through some of the minute holes in the shell, and carbonic acid constantly exhaled from others. A portion then of the organic molecules begins to run down, and is converted into carbonic acid, and, possibly, water. During this process power is evolved within the shell—we cannot say, in the present state of science, under what particular form; but we are irresistibly constrained to believe that it is expended under the direction, again, of the vital principle, in re-

arranging the organic molecules, in building up the complex machinery of the future animal, or developing a still higher organization, connected with which are the mysterious manifestations of thought and volition.

In this case, as in that of the potato, the young animal, as it escapes from the shell, weighs less than the material of the egg previous to the process of incubation. The lost material in this case, as in the other, has run down into an inorganic condition by combining with oxygen, and in its descent has developed the power to effect the transformation we have just described.

We have seen, in the case of the young plant, that after it escapes from the seed, and expands its leaves to the air, it receives the means of its future growth principally from the carbon derived from the decomposition of the carbonic acid of the atmosphere, and its power to effect all its changes from the direct vibratory impulses of the sun. The young animal, however, is in an entirely different condition; exposure to the light of the sun is not necessary to its growth or existence; the chemical ray, by impinging on the surface of its body, does not decompose the carbonic acid which may surround it, the conditions necessary for this decomposition not being present. It has no means by itself to elaborate organic molecules, and is indebted for these entirely to its food. It is necessary, therefore, that it should be supplied with food consisting of organized materials, that is, of complex molecules in a state of instable equilibrium, or of power. These molecules have two offices to perform: one portion of them, by their transformations, is expended in building up the body of the animal, and the other in furnishing the power required to produce these transformations, and, also, in furnishing the energy constantly expended in the breathing, the pulsations, and the various other mechanical motions of the living animal. We may infer from this that the animal, in proportion to its weight before it has acquired its growth, will require more food than the adult, unless all its voluntary motions be prevented; and secondly, that more food will be required for sustaining and renewing the body when the animal is suffered to expend its muscular energy in labor or other active exercise.

The power of the living animal is immediately derived from the running down of the complex organized molecules, of which the body is formed, into their ultimate combination with oxygen, in the form of carbon, water and ammonia. Hence, oxygen is constantly drawn into the lungs, and carbon is constantly evolved. In the adult animal, when a dynamic equilibrium has been attained, the nourishment which is absorbed into the system is entirely expended in producing the power to carry on the various functions of life, and to supply the energy necessary to perform all the acts pertaining to a living, sentient, and, it may be, thinking being. In this case, as in that of the plant, the power may be traced back to the original impulse from the sun, which is retained through a second stage, and finally given back again to celestial space, whence it emanated. All animals are constantly radiating heat, though in different degrees, the amount in all cases being in proportion to the oxygen inhaled and the carbon ex-

haled. The animal is a curiously contrived arrangement for burning carbon and hydrogen, and the evolution and application of power. n this respect it is precisely analogous to the locomotive, the carbon burnt in the food and in the wood performing the same office in each. The fact has long been established, that power cannot be generated by any combination of machinery. A machine is an instrument for the application of power, and not for its creation. The animal body is a structure of this character. It is admirably contrived, when we consider all the offices it has to perform, for the purpose to which it is applied, but it can do nothing without power, and that, as in the case of the locomotive, must be supplied from without. Nay, more, a comparison has been made between the work which can be done by burning a given amount of carbon in the machine, man, and an equal amount in the machine, locomotive. The result derived from an analysis of the food in one case, and the weight of the fuel in the other, and these compared with the quantity of water raised by each to a known elevation, gives the relative working value of the two machines. From this comparison, made from experiments on soldiers in Germany and France, it is found that the human machine, in consuming the same amount of carbon, does four and a half times the amount of work of the best Cornish engine. The body has been called "the house we live in," but it may be more truly denominated the machine we employ, which, furnished with power, and all the appliances for its use, enables us to execute the intentions of our intelligence, to gratify our moral natures, and to commune with our fellow beings.

This view of the nature of the body is the furthest removed possible from materialism; it requires a separate thinking principle. To illustrate this, let us suppose a locomotive engine equipped, with steam, water, fuel—in short, with the potential energy necessary to the exhibition of immense mechanical power; the whole remains in a state of dynamic equilibrium, without motion or signs of life, or intelligence. Let the engineer now open a valve which is so poised as to move with the slightest touch, and almost with volition, to let on the power to the piston; the machine now awakes, as it were, into life. It rushes forward with tremendous power, it stops instantly, it returns again, it may be, at the command of the master of the train; in short, it exhibits signs of life and intelligence. Its power is now controlled by mind—it has, as it were, a soul within it. The engine may be considered as an appendage or a further development of the body of the engineer, in which the boiler and the furnace are an additional capacious stomach for the evolution of the power; and the wheels, the cranks and levers, the bones, the sinews, and the muscles, by which this power is applied.

There is, however, one striking difference between the animal body and the locomotive machine which deserves our special attention, namely, the power in the body is constantly evolved by burning, as it were, parts of the materials of the machine itself, as if the frame and other portions of the wood-work of the locomotive were burnt to produce the power, and then immediately renewed. The voluntary motion of our organs of speech, of our hands, of our feet, and of every

muscle in the body, is produced, not at the expense of the soul, but at that of the material of the body itself. Every motion manifesting life in the individual is the result of power derived from the death, as as it were, of a part of his body. We are thus constantly renewed and constantly consumed, and in this consumption and renewal consists animal life. When the proper balance between these two processes is destroyed, the derangement and death of the body ensue. The rational, directing, thinking, willing soul, analogous to that Divine intelligence manifested in all the works of Nature, dissolves its connexion with matter, and finds in another, and perhaps successive conditions, an immortal existence.

In this great perpetual circle of change nothing is lost. The earthy matter absorbed by the roots of the plant are given back to the earth in the dejectments and decay of the animal body; the carbon, the hydrogen, the nitrogen, are returned to the air whence they were drawn; the solar impulses by which all the transformations were effected, are given off unaltered in quantity to the celestial space; and, in the case of man, the soul, fraught with the moral effects of its connection with matter, returns to its Divine Creator, the source of all power, moral, intellectual, and physical.

MECHANICAL ENERGY.

The last remarks will lead us naturally to the subject of mechanical energy and the correlation of physical forces, a comparatively new class of ideas, which is at present occupying the attention of some of the first men of Europe and this country. Indeed, one reason which has induced us to adopt the atomic theory in this essay is, that we might give the clearest and simplest view of these new and interesting ideas, as well as some of the deductions which have been made from them. The fact has been long conclusively established in the minds of scientific men, that matter cannot be annihilated, except by the almighty fiat of Him who called it into existence; and the idea has been lately adopted, that the natural forces associated with matter, namely, the attractions and repulsions, are also as indestructible as the matter itself; moreover, the tendency of scientific speculation at the present day is to the conclusion, that all energy, as it is called, or that which produces the changes in the material universe, is due to the movements produced by attraction and repulsion of the atoms in passing from a primordial state of instability to one of final stability or relative rest. It must be evident to any person who is acquainted with the simplest principles of mechanics, that in a universe in which all the atoms are in equilibrium, or have approached each other as nearly as possible, there can be no spontaneous motion. Such a universe must ever remain, in all its parts, a dead, inert, and lifeless mass. It can only be awakened to life and motion by the application of power from without.

Mechanical energy is only exhibited while two atoms are rushing together; when they have united in combination, they exhibit an apparent neutralization of all power to produce change in themselves

or other bodies. "Fill," says Mr. Faraday, "an India-rubber bag with a mixture of oxygen and hydrogen in the proportion of 8 parts to 1 by weight; and, blowing up a number of soap bubbles in a large dish to confine the gases, apply a lighted taper to the bubbles and observe the result. It is a violent deafening explosion, attended with the evolution of light and heat, giving evidence of tremendous power. But let us now consider the result of this explosion. What is it? Water, and nothing but water. To me, the whole range of natural phenomena does not present a more wonderful result than this. Well known, and familiar though it be—a fact standing on the very threshold of chemistry—it is one over which I ponder again and again with wonder and admiration. To think that these two violent elements, holding in their admixed parts such energy, should wait until some disturbance is effected, and then rush furiously into combination, and form the bland and unirritating liquid water, is to me, I confess, a phenomenon which awakens new feelings of wonder as often as I view it."

Wonderful as this may appear, it is but a simple illustration of a general law. The power exhibited was in the momentum produced by the energetic action of the two atoms on each other, and the consequent high velocity with which they rushed into union. The noise produced was due to the intense agitation given to the air; the light and heat to the agitation of the ethereal medium; and these together are equal to the energy generated by the reciprocal motion of the atoms. If by any means a force were applied to separate the atoms to the same distance at which they were at first, this force would be just equal to that due to the rushing together of the atoms. Two atoms separated, and in a condition to be violently drawn together, are said to be in a state of *energy* or *power;* but when they have entered into combination, they are then in a state of inertness. The same may be said of a weight elevated above the surface of the earth. A certain amount of muscular power must be exerted to overcome the attraction of gravitation, and to raise the weight to the given height, say ten feet. It is then in a state of power, or in a condition to produce permanent changes in matter, and other effects which we technically denominate work.

The energy developed in the weight may be employed to drive a pile into the ground, or it may be made to turn a mill and grind corn; but the work done in these two cases, when properly measured, will be the same, and just equal to that expended in elevating the weight. If the weight be raised to double the height, twice the force will be expended in accomplishing this effect, and the weight in its descent to the earth will also do a corresponding amount of work. The explanation of the development of the energy exhibited in the fall of a body from a height will be plain, when we consider that gravity acts on the mass with a force proportioned to the number of pounds in its weight at every point in its descent; and if we suppose that in the first instant this attraction gave it a certain velocity, and gravity were then to cease, the body, on account of its inertia, would continue to descend with this velocity to the end of its course. But if

the attraction continues to act, new impulses are imparted at every instant, and the velocity will continually increase until it reaches the ground, where it will produce an effect which is the equivalent of the power accumulated in its descent. The mechanical energy of matter, therefore, is measured by the distance of the atoms into the intensity of the attraction at the different points of their path of approach. If the atoms of any part of the material universe are in the condition of the atoms of oxygen and hydrogen after they have united to form water, that is, in the closest approximation and a complete neutralization of their affinities, the matter in this portion of space will be entirely inert, and, unless disturbed by extraneous force, no change can take place among its parts. Matter wanting that peculiar characteristic which eminently distinguishes mind, namely, spontaneity of action, all will be in perfect quiescence.

From the researches of the geologist, the chemist and the physicist, we are enabled to assert that such is the condition of our earth and its attendant satellite. All the chemical elements which are found in the crust of the globe have gone into a state of permanent quiescence. The metals and oxygen have united to form oxides, and these with the acids to form other stable compounds; and were it not for the disturbing influence of the impulses from the sun, the present system of continued change, of growth and decay, of storms and of calms, would cease, and the whole surface of our planet would exhibit a dreary desolation of darkness and stillness, of silence and death. Indeed, as it is, the changes and ever-varying phenomena in which we are so much interested, and a knowledge of which constitutes the highest earthly wisdom, are confined to an almost infinitesimal pellicle at the surface of the earth. Organic matter is found but a few feet below the surface of the soil, and plants cannot exist in the ocean beyond the depth to which the rays of the sun penetrate. But this state of things has not always existed. It is conclusively proved by the past history of the globe, as written upon the rocks which form its outer strata, that its atoms were once in a state of intense agitation, or, in other words, that the globe was in a condition of high temperature, and that the vibrations have been imparted to the surrounding ethereal medium and thus radiated off into space. We arrive at this conclusion, not only from an examination of the condition of the strata, but from the fact that wherever we penetrate beneath the surface, beyond the depth of the influence of external climate, the temperature uniformly increases at the rate of about 1° for every 50 feet. Our globe, then, consists of a mass of matter which has been gradually cooled from a state of high intensity, and at its surface has arrived at a condition of equilibrium, the heat which its surface gives off into space being just compensated by that received from the sun. The permanency of our temperature, therefore, depends upon that of the great central luminary of our system itself. But whether

> "The sun himself shall fade,
> And ancient night again involve a desolate abyss,"

must be left for future consideration.

The ideas which are here given had their origin in the attempts which were made to produce self-moving machines. The possibility of such contrivances appeared to be sanctioned by the apparently spontaneous motion of men and lower animals. The idea that these motions were the results of the chemical action of food had not yet entered the mind; and it was only after many fruitless attempts, and the expenditure of much thought, time, and labor, that the conclusion was at length arrived at that a machine is a mere instrument for the application and modification of power or energy, and that in no case can it do more work or produce more changes in matter, or, in other words, it can break apart no more atoms, than are equivalent to the power which has been applied to it. The same amount of power which we apply at one extremity of a machine, properly estimated, is equal to the sum of the resistances at the other, and the two precisely balance each other. From considerations of this kind we arrived at the conception of the correlation of the physical forces and the reconversion of the equivalent of one into that of the other.

We may do the same work by heat properly applied, or by a fall of water, or by muscular energy. For example, a disc of iron may be made to revolve rapidly with a mill driven by a fall of water, and if this is allowed to rub with some pressure against another iron plate, a great amount of friction will be produced; the mechanical collision of the surfaces will set the atoms of the plates in that state of vibration which constitutes heat, and which, if unobstructed, will be communicated to the surrounding ethereal medium, and radiated to adjacent bodies or off into celestial space. But if detained and applied, it may be used to produce changes in matter, such as the boiling of water, the driving of a steam engine, and other objects. Now, if it were possible to collect and concentrate all the impulses of the heat vibrations, and apply them without loss by means of a machine to the elevation of water, the quantity thus raised and the height to which it is raised would be precisely equal to the height and quantity of water, the fall of which produced the first effect. Similarly, if by a steam engine we put in motion the plate of a large electrical machine and disturb the equilibrium of the ether, condensing a portion of it in one part of space and rarefying it in another portion, the force which would be exerted in the restoration of the equilibrium, or in the electrical discharge, would be just equal to the amount of energy exerted in producing the coerced condition. If in this case the coerced equilibrium is retained for a day, a year, or a century, so long the amount of energy expended to produce it will, as it were, be locked up, but not lost. It will be ready to appear and do work as soon as the detent which prevents the commencement of motion is removed. As a further example of this, suppose a heavy weight to be elevated by steam power to the top of a high pillar, and there placed on an equipoise, so that the least force applied may overturn it and enable it to commence its fall. In its descent it will receive at every instant a new impulse from gravity, and when it arrives at the ground it will expend its accumulated energy in penetrating the surface and in the production of heat, sound, and tremors

of the earth. When the weight is resting on the top of the pillar, ready to fall off with the slightest touch, it is said to be in a state of potential energy; and when it has almost reached the earth and is moving with the full velocity of the fall, it has converted its potential energy into actual power.

The general conclusion which has been arrived at is, that all the different physical energies, whether that which is called chemical action, heat, light, electricity, magnetism, or muscular motion, or mechanical power, are all referable to the disturbance of the equilibrium of the atoms, and its subsequent restoration due to their attractions and repulsions; and that all these forms of energy are, in one sense as it were, convertible into each other; or, in other words, the force generated in the restoration of the equilibrium in one case is sufficient to disturb it, though in a different form perhaps, in another. We must guard against the erroneous idea which some have inconsiderately adopted, that one form of power can be actually converted into another, as heat into electricity, or the converse. The theory of energy merely declares that the power exhibited in the electrical discharge is the equivalent of the muscular energy expended in charging the battery, and not that muscular energy is converted into electricity.

The origin of heat produced by friction for a long time perplexed the most sagacious philosophers. Our celebrated and ingenious countryman, Count Rumford, caused a quantity of water to boil for several hours by the heat generated in boring a cannon; and after the process was ended, he found that the borings and the cannon contained as much heat as at the commencement of the experiment. From this result he boldly proclaimed that heat was not matter, but the vibrations of the atoms of matter, and that in his experiment the heat was generated by the friction of the drill on the metal.

Later researches have constantly tended to strengthen the probability of this view, and even to establish the general fact, that when mechanical power is produced by the expenditure of heat, a quantity of heat disappears, bearing a fixed proportion to the power produced; and conversely, that when heat is produced by the expenditure of mechanical power, the quantity of heat produced bears a fixed proportion to the power expended. Thus, in the case of a steam engine doing no work, the quantity of heat given out in the waste-pipe would just be equal to that received into the boiler, provided there was no loss from conduction and radiation; but in the engine drawing up water, for example, a quantity of heat is actually annihilated in doing the work. The vibrations of the atoms, which constitute heat, are stopped in giving motion to the piston-rod. Conversely, if the water, which has been pumped up to an elevation, were made in its descent to produce heat by means of revolving disks, the amount generated would be just equal to that which disappeared in the other case.

For practical purposes, it is, therefore, of great importance that the ratio of equivalents of heat and mechanical power should be accurately determined, and for this purpose M. Jule, of Manchester

has made a series of most delicate and beautiful experiments on the heat evolved by the revolution of paddle-wheels in baths of water, mercury, or oil. Motion was given to the paddle-wheels by a known weight descending from a given height; the amount of heat was found to be precisely the same with a given expenditure of mechanical power, whether the wheel revolved in water, mercury, or oil, proper allowance being made for the different densities and the different capacities of these bodies for heat. In this way, he found that the fall of a weight of one pound through 772 feet, or what would be the equivalent, the fall of a weight of 772 pounds through one foot, was just sufficient to raise the temperature of one pound of water one degree of Fahrenheit's scale. Seven hundred and seventy-two pounds falling through one foot is, therefore, considered as the unit of the working power of heat; and, in honor of the investigator who has thus enriched modern science with one of its most valuable means of calculation, applicable to every part of physical research, it is denominated "Jule's unit." By it we are enabled to express in terms of the descent of a weight the equivalency of all the forces of Nature, and thus to reduce the mechanical conception of their relations to its greatest simplicity, and to apply mathematical reasoning to a variety of problems heretofore excluded from the province of this great logical instrument, so essential in the deduction of effects from complex relations. The descent of a weight is chosen, because it is perhaps the most familiar, and of the easiest conception and application. The value of a fall of water is always estimated by the quantity of liquid multiplied by the height, through which it descends. If we multiply these together, and divide by 772, we shall have the number of degrees of heat that this will impart to a pound of water; and conversely, by knowing the number of degrees of heat as measured by the number of pounds of water raised one degree, we shall have the number of pounds of water which can be elevated to a given height by a perfect machine; and when such effects are submitted to this calculation, we find that the steam engine, in its most improved form, is far from utilizing all the heat applied to it; by far the greater portion is expended in the separation of the atoms of water in radiation, in overcoming friction, and in the production of vibration and useless motion.

Mr. Jule also established the relations of equivalence among the energies of chemical affinities of heat, of combination, or of combustion, of electrical currents in the galvanic battery and in electro-magnetic machines, and of all the varied and interchangeable manifestations of caloric action and mechanical force which accompanies them. A series of experiments has also been made on the heat of animals, which is found to be the equivalent of the chemical combination of the food and the oxygen which they inhaled.

The influence which investigations of this kind are to have on the future history of mechanical arts and the production of labor-saving machines, and on the increased power of man in controlling the innate forces of matter, it is impossible to estimate.

"The food of animals is either vegetable or animals fed on vegetables, or ultimately vegetable after several removes. Except mushrooms and other fungi, which can grow in the dark, are nourished by organic food like animals, and, like them, absorb oxygen and exhale carbonic acid, all known vegetables get the greater part of their substance—certainly all their combustible matter—from the decomposition of carbonic acid and water absorbed by them from the air and soil. The separation of carbon and of hydrogen from oxygen in these decompositions is an energetic effect equivalent to the heat of recombination of those elements by combustion or otherwise. The beautiful discovery of Priestley, and the subsequent researches of Sennebier, De Saussure, Sir Humphrey Davy, and others, have made it quite certain that those decompositions of water and carbonic acid only take place naturally in the daytime, and that light, falling on the green leaves, either from the sun or an artificial source, is an essential condition without which they are never effected. There cannot be a doubt but that it is the dynamical energy of the luminiferous vibrations which is here efficient in forcing the particles of carbon and hydrogen away from those of oxygen, toward which they are attracted with such powerful affinities, and that luminiferous motions are reduced to rest to an extent exactly equivalent to the potential energy thus called into being. Wood fires give us heat and light which have been got from the sun a few years ago. Our coal fires and gas lamps bring out, for our present comfort, heat and light of a primeval sun, which have lain dormant as a potential energy beneath seas and mountains for countless ages."—*Prof. Thompson.*

A striking example of the transformation, as it were, of the force of motion into heat is exhibited by an article of apparatus now in the cabinet of the Smithsonian Institution, and devised by M. Leon Fourcault, of Paris. Between the poles of a strong electric magnet a heavy metallic disc is made to rotate, and although the revolving body does not touch the magnet, yet its motion is stopped by it in a few seconds. The momentum of the disc which is thus overcome gives rise to heat; for the reaction of the magnet produces a current of electricity, and in the resistance to this the heat is generated. A body in motion is in a state of power, and it cannot come to rest without producing some effect on the surrounding matter. The ultimate effect in this case is an agitation of the atoms of the metal.

CONDITION OF THE EARTH IN SPACE.

Having given a general view of the atomic theory in its widest generalizations, we now propose to consider its application to the physical phenomena of our globe. For this purpose, we will briefly recall some of the elementary facts of astronomy.

The earth is a globe slightly flattened at the poles, isolated in space, supported upon nothing, and only connected with other bodies of the universe by the all-pervading force of attraction in connection with them, through the impulses of the ethereal medium. In this

free space it turns upon itself with a regular motion around an ideal axis which pierces its surface at two opposite points or poles, which have never varied their position. It also moves in space, describing around the sun, in the course of a year, a slightly elliptical curve called its orbit. But this movement of translation around the sun does not interfere with the rotation of the earth around its axis; for, in accordance with the second fundamental law of motion, two motions of this kind may exist in a body at the same time. If the earth's axis were at right angles to the plane of its orbit, but slight variations would be found in the temperature at its surface in different periods of the year. The axis, is not, however, thus placed, but is inclined at an angle of about twenty-three and a half degrees to the plane above mentioned; and this fact, which at first sight might appear of little consequence, in reality produces all the alternations of seasons, and is connected with all the changes of climate of the surface of the globe. Gradual changes of climate cannot be produced by a change in the axis of rotation, as some have supposed, since this would alter the whole form of the earth, and produce other changes incompatible with the facts of observation.

The position, the form, and the movement of the earth are similar to those of the other planetary masses which we see isolated in space under the form of globes, turning around on an axis within themselves, and around the sun in elliptical curves. While we observe that the earth is the centre of the orbit of our moon, we see that four moons turn around Jupiter, seven around Saturn, and six around Uranus. A planet, with the moons which accompany it, form what is called a *planetary system*, and all the planets taken together, with the sun, constitute what is denominated the *solar system*. In this system the earth occupies the third place from the sun, from which it is removed ninety-five millions of miles at its mean distance. Neptune occupies the most distant limit, and is more than thirty times further removed than the earth from the principal centre of influence. But these distances, though greatly beyond our definite conceptions, are nothing in comparison with the intervals which separate the sun from the fixed stars. These bodies, like the sun, are self-luminous, and are, without doubt, centres of planetary systems; but they are at such an inconceivable distance that light itself, which requires but eight minutes to reach us from the sun, occupies years of time in its journey from the nearest of them. But all the stars which are visible to the naked eye form only a single group, which, if viewed at a sufficient distance, would appear in the heavens as only a luminous cloud or spot, and would resemble the nebulous patches which we perceive here and there in different parts of the heavens by the aid of powerful telescopes. This universe, then, unbounded by human intelligence, is composed of isolated groups of stars, and perhaps of orders of arrangement still more elevated. In this magnificent assembly our nebula is only a spot in the infinity of spots; our sun is only a star in the midst of the stars of the group to which it belongs; and among the planets which revolve around our sun, the earth is one of an inferior order.

Starting from the grouping of gross atoms, which we have previously given, and extending the analogy, the thought has been expressed that our earth might be compared to an atom; the earth and moon to a compound atom; the whole system to a molecule; and our sun, and all the stars of the group to which it belongs, as the great solid of solids, and thus in one conception embracing the whole material universe. But, to limit our speculations, we may inquire whether the infinity of stars by which we are surrounded have any influence upon the climate and temperature of this earth.

Influence of the stars.—It is well known that at one time the stars were supposed to influence human destiny, and though astronomy has discarded most of the pretensions of her progenitor, astrology, yet, in this instance, modern science has shown that the stars have really a physical influence upon our earth and on every other planet of our system. If from any point in space a line be extended in thought in any direction, it will ultimately meet a radiating body; and hence every point in space must be constantly traversed from all directions with radiating impulses which give it a definite and fixed temperature. For example, our sun sends a ray to every point of the universe, and every other sun sends a ray to the same point, and the sum of all these rays will constitute the temperature of that point. We say the *temperature* of that point, by which we mean the effect which would be produced upon a thermometer if put in that place; not that there is any temperature in celestial space, for this, as we have seen, belongs to gross matter, and is produced by the motion of its atoms. The term, however, is convenient, and we shall continue to use it.

If the radiating power of the suns remained without change, then the temperature of each point in space would be unchangeable. From this consideration it follows that, independent of the heat of the sun, the planetary space in which our earth is moving has in one sense a fixed temperature derived from all the other suns of the universe; and this temperature, as we shall hereafter see, has a marked influence on the temperature of the globe.

We shall return to this subject again, and at present shall merely state that at the polar regions of our earth, during the months of winter, the space immediately contiguous to the surface is screened from the heat of the sun, and consequently the earth, by its radiation, must sink in temperature nearly to that due to celestial space. A similar screening takes place in succession on all parts of the earth's surface during the night; and as the loss of heat by radiation depends, as we shall see, upon the temperature of the space into which the rays are sent, every part of the earth's surface must be affected more or less by the temperature of interplanetary space; and if this were to vary, though our sun might continue constant in its emanation, the average terrestrial temperature would be subject to a change.

We cannot, however, explain the effect of the temperature of planetary space upon our earth until we have further considered the subject of heat.

HEAT OF THE EARTH

The temperature of the earth is derived from three sources, namely. the *original* heat of the earth, the heat of celestial space, and the heat of the sun. Before, however, giving an account of the heat derived from these sources, we shall first consider the character of radiant heat, as developed by the researches of Melloni and others.

Radiant heat.—The impulses which are received from the sun, as we have seen, are far from being simple in their nature. We know that a beam from this luminary consists of at least four different classes of emanations, namely, of light, of heat, of chemical action, and of phosphorogenic effect. We also know that the first class, that of light, consists of a number of different emanations which produce in us the sensations of the different colors of the spectrum, and from analogy we might have inferred that the heat emanations also consist of a number of rays, possessing different properties, and producing at the surface of the earth different physical and perhaps physiological effects.

Let us begin with heat of the lowest intensity, or that which is supposed to be composed of waves of the greatest length; for example, the radiation from a canister of hot water suspended in mid-air. If this is elevated in the least degree above the temperature of the surrounding bodies, they will increase in temperature, while the vessel itself will slowly cool. The rapidity of cooling will gradually diminish in a geometrical ratio, as the temperature of the canister approaches that of the surrounding bodies, and they will finally arrive at a state of dynamic equilibrium. The canister, at this point, does not cease to radiate, but continues to send impulses in every direction, receiving as many impulses from the surrounding bodies, including the air, as it sends off from its own surface.

The heat from this source possesses peculiar properties. First, it is readily absorbed by all bodies in proportion to some peculiarity of the texture of their surface, but is *wholly independent of the color;* or, in other words, this kind of heat, unlike light, is absorbed by light-colored substances as well as dark, and this fact would be in accordance with the hypothesis assumed, which supposes these two emanations to consist of waves of different lengths, and perhaps of slightly different form. Secondly, this kind of heat is incapable of passing by direct radiations through many media, which are freely traversed by light, such as glass, alum, and many other transparent substances, while it is freely transmitted through polished plates of rock-salt, and partially through many other bodies, some of which are impervious to light. The first class of bodies are called *athermanous*, the latter *diathermanous.*

Let us now suppose the radiating body to be one which can be increased in temperature until it becomes red-hot. At a certain stage of incandescence, other rays than those described capable of exciting heat begin to be given off along with the former, which are distinguished by different properties. First, they tend to be absorbed

by all bodies in proportion to the darkness of their color, and approximate in this respect to the property of light. Secondly, they possess a property of transmissibility without diminution, through all transparent substances, through colorless media, and in various proportions through colored media, according to the nature of the latter.

While bodies heated below redness give off exclusively rays of the first class, though approaching in character those of the second, as the temperature is increased, incandescent bodies simultaneously give off both species.

As the intensity of heating still further increases, rays of less and less length are given off, until they arrive at the limit of the perceptibility of the sense of vision, and only render their existence manifest by chemical and phosphorogenic effects.

The following table exhibits some of the results which Melloni obtained by experimenting with different sources of heat and different substances:

Relative absorbability of different kinds of heat by different substances.

SUBSTANCES.	Naked flame.	Incandescent platinum.	Copper, at 75° F.	Copper, at 212° F.
Lampblack	100	100	100	100
White lead	53	56	89	100
Isinglass	52	54	84	91
Indian ink	96	95	87	85
Shellac	43	47	70	72
Polished metal	14	13.5	13	13

As an illustration of the effects of radiant heat of different kinds, we may mention the fact, long observed, of the melting of snow near the trunks of trees and other dark-colored bodies. That this effect is not due to the natural heat of the plant is evident, from the fact that it is equally exhibited around the stumps of dead trees, and dark-colored objects of an entirely different character. The rays of heat from the sun, as we have before stated, are those possessing luminous properties, are absorbed by dark substances, and freely reflected from light ones. The facets of the small crystals of snow reflect this heat almost entirely, while it is absorbed by the dark surface of the wood of which it raises the temperature, thus producing a new source of emanation. The heat however given off from the wood, is that of long waves of low intensity, which is equally absorbed by light and dark bodies; hence it enters the snow, raises its temperature, and converts it from a solid to a liquid condition. We may imitate this action by supporting at a little distance above a surface of new fallen snow a piece of pasteboard, both sides of which have been covered with lampblack, and the whole being freely exposed to the sun's rays. It will be found that the melting of the surface within the shadow is much more rapid than that exposed to

the direct rays of the sun. The same result may be produced by the rays from an argand lamp. Having filled a square box with new fallen snow slightly packed, and all above the rim having been removed by means of a ruler, so as to present a uniformly plain surface, the box is turned on its side opposite the lamp, and the pasteboard interposed. In a short time the plain surface of snow will be hollowed out beneath the disk, and at the end of half an hour the cavity will be several lines deep at its centre. When the same experiment is repeated by substituting for the lamp an iron ball heated to about 400° F., the phenomena present themselves in a reverse order, that is to say, the melting of the snow would be more abundant where the direct rays impinge on the surface, than where they are intercepted by the interposed disk, and instead of a hollow, a protuberance would be produced at the centre of the shaded portion. If we substitute in this experiment for the black disk of pasteboard one covered with white lead, the heat will not be absorbed, but will be reflected as from the snow itself.

Another example of the transmission and, as it were, transformation of radiant heat from the sun is afforded in the high temperature produced by the ordinary hot-bed of a garden. The solar rays, consisting of short vibrations, readily pass through the glass cover, and are adsorbed by the dark ground, the atoms of which they put into more rapid vibration, and these, in turn, give rise to new emanations, which, consisting of long waves, are arrested by the glass, and thus the temperature of the enclosed space is constantly increased. It is also on the same principle that the radiant heat of a stove does not pass out into space through the windows of a house, though a considerable portion of the radiant heat from an open fire would be lost in this way.

We may apply the foregoing principles to explain the accumulation of heat at the surface of the earth. The transparent envelope which covers the surface of our planet, is not entirely diathermanous; and though it transmits freely the intense rays of the sun, it stops those of the long vibrations. The surface of the earth is then in the condition of the ground under the glass of the hot-bed; it is constantly absorbing and receiving heat of high intensity, and constantly radiating off heat of intermediate intensity. Let us suppose all heat removed from the earth, and the sun suddenly allowed to shine upon it. In this case, all the rays which traversed the atmosphere and reached the earth would be absorbed. None would be radiated into space until the temperature of the surface was so elevated that the rays emitted from it could permeate the atmosphere.

The surface of the earth at first would therefore receive more rays than it gave off. Its temperature would increase, and with each increase of temperature a greater number of rays would be produced of such intensity as would enable them to permeate the atmospheric envelope, and finally an equilibrium would be attained in which the rays sent off in a given time would be just equal in number to those received.

The point of temperature at which this equilibrium would take

place will depend on the height and permeability of the atmosphere. If the aerial envelope offered no impediment to the escape of heat of the lowest intensity, the equilibrium would take place at so low a temperature that all bodies capable of freezing would perpetually be in a solid state. If, on the other hand, the atmosphere were more dense than it is, or, in other words, more impervious to rays of a higher intensity than those which now pass through it, the temperature of the surface of the earth would increase until the heat given off would again be equal to that received. The new equilibrium would be permanently retained, and the whole average temperature of the surface of the globe would be elevated.

Heat from the stars.—The temperature, therefore, of the surface of a planet depends upon the nature of its atmosphere, provided the heat which falls upon it is derived from a source of high temperature. Now, radiations from the stars are of this character, since they come from self-luminous bodies, which are probably suns of other systems. The radiations from them can, therefore, readily pass through our atmosphere, and excite heat vibrations in the materials of the surface of the earth. The intensity of these vibrations must increase until it becomes so great that the radiations produced can permeate the aerial covering, and in this way even the heat of the stars may so accumulate as sensibly to contribute to the temperature of the earth. Though at first sight it might appear that the effect from this source must be exceedingly feeble, yet when we reflect that the heat of the stars comes from every part, as it were, of the whole concave of the heavens, while that of the sun proceeds from a disk which occupies only the five-millionth part of the whole sky, we may be inclined to attribute to the stellar radiation a much greater importance than without this reflection we should ascribe to it.

M. Pouillet, of Paris, has made a series of very ingenious researches on the subject of the temperature of space, and has arrived at very unexpected results. He employed in his observations an instrument to which he gave the name of "actinometer," or ray-measurer. It consisted of a cylindrical box of polished silver, about eight inches in diameter, and five in height, enveloped in swan's-down, and enclosed in an outer cylinder, so as to prevent as much as possible the effect of the temperature of the circumambient air. The box was filled with several layers of swan's-down, so supported as not to press upon each other. In the centre of the upper surface of the open box was placed the bulb of a thermometer, the stem projecting horizontally. A cylindrical border was raised round the edge of the box, to cut off the lateral rays, and at such a height that two-thirds of the whole sky could be seen by an eye at the point occupied by the bulb. The thermometer, thus enclosed, was turned during the night to the zenith, and exposed to the radiation from the clear sky. The temperature of this thermometer and one exposed to the air at four feet from the ground was observed hourly.

If the heat of the surrounding air were entirely excluded from the enclosed thermometer, it is evident that it would only be affected by

the radiation from celestial space, and from the atoms of the air in the column between it and the top of the atmosphere.

Of these two sources of radiation, one, namely, that of celestial space, would be constant, and remain the same during the whole night, as well as different nights, while the other, namely, the radiation from the air, would vary from hour to hour, since it depends on the varying temperature of the atmosphere.

By obtaining a series of observations in different states of the atmosphere an assumption could be made as to the fixed temperature of space, which, when subtracted from the temperature observed, would give the radiation of the column of the atmosphere.

Since it was impossible to cut off all the heat from the instrument except that which it receives from the sky and air above, and since it was exposed to but two-thirds of the celestial hemisphere, some correction was necessary to reduce the observed temperature to the true one. This was found by making an artificial sky, formed of a zinc vessel about forty inches in diameter, the bottom coated with lampblack, and the whole filled with a refrigerating mixture. Beneath this the "actinometer" was placed vertically at such distances as to expose it successively to one-quarter, one-third, and two-thirds of the hemisphere; and by repeating these experiments with different temperatures of the artificial sky, it was found that if from the temperature of the surrounding air $\frac{9}{4}$ of the lowering temperature of the actinometer were taken away, the temperature of the artificial sky would be obtained, since the same ratio would obtain in the case of the real sky. In order to find, therefore, in all future experiments the temperature which the actinometer ought to assume under the radiation from space and the air above, it was only necessary to subtract the degree given by the instrument from the temperature of the surrounding air and multiply this by $\frac{9}{4}$. From a series of observations thus corrected, he found for the fixed part of the temperature given by the instrument, or, in other words, the temperature of space, a value of — 142° C. or — 222° F. This temperature is much lower than that obtained before from considerations of a more theoretical character. M. Pouillet, however, thinks that it cannot be far from the true temperature of celestial space, since a thermometer placed upon the coldest part of the earth, and exposed to the clear sky, always falls by its own radiation several degrees lower than the temperature of the air; which it would not do if the temperature of space were not lower than — 60°, since as it approached that temperature at places near the pole, the extra cooling from exposure to the sky would be very little. Mr. Espy concludes, from theoretical data, that the estimate of Pouillet is near the truth.

He finds, from the data given above, that the total quantity of heat which space transmits in the course of a year to the earth and atmosphere, would be sufficient to melt a stratum of ice upon our globe of 86½ feet in thickness. From other investigations of a similar character, which we shall presently describe, he finds that the quantity of solar heat received by the earth in the course of a year is sufficient to melt 103¼ feet of ice. From these two sources together, then, the

earth receives a quantity of heat sufficient to melt 190 feet of ice. These results are of so unexpected an amount that, though obtained by instruments and methods which are apparently unexceptionable, they have not fully obtained acceptance, and the subject is therefore still open for further examination.

Terrestrial temperature.—If the earth were exposed in space without an envelope and without receiving radiation from any source, it would sink to the zero of temperature, or that at which the atoms would cease to vibrate, and this, according to the mechanical theory of heat, would be about 500° below the freezing point of Fahrenheit's scale.

If the earth were exposed without an envelope to the temperature of space it would, according to the results obtained by Pouillet, fall to — 222° of the same scale.

With the present envelope and stellar radiation it would stand at 128°. The heat necessary to make up the actual temperature of the earth beyond this degree is due to the sun's accumulated heat under the envelope.

Pouillet has also made a series of researches on the absolute amount of heat from the sun. He used in his investigations an instrument to which he gave the name of pyr-heliometer (measurer of the heat of the sun.) It consisted of a flat cylindrical vessel, the top of which was of thin silver, of about four inches in diameter and six-tenths of an inch in height or thickness. It was filled with 100 grammes of distilled water, and in the middle of this liquid was placed the bulb of a thermometer with a fine bore and a long stem projecting downwards in the direction of the axis of the cylinder through its lower surface.

The observations were made in the following manner: The upper surface of the vessel, coated with lampblack to render it absorbent of heat, was turned directly towards the sun, the water being kept in a state of constant agitation in order to equalize the heat. The increase of temperature received from minute to minute in the course of five minutes was noted. The vessel was then placed in the shade while its face was exposed to a portion of clear sky near the sun, and the loss of temperature from minute to minute, during five minutes, was again noted. A little reflection on the principles of the interchange of heat, according to which bodies are constantly radiating even while they are receiving heat from other bodies, will render it evident that in order to find the amount of temperature communicated by the sun in a minute of time, we must add the loss of temperature during the shading of the instrument to the gain of temperature noted during the direct exposure to the sun, for while the instrument was receiving heat from the sun it was at the same moment radiating heat to that body. To find, from the indications thus obtained, the absolute amount of heat which falls on the face of the vessel in one minute of time, we must make a correction for the absorption of heat by the metal, and allow for the specific heat of the water, that is, the relative quantity necessary to elevate a pound of this liquid one degree of Fahrenheit's scale. In this way the quantity of heat which falls on a given surface, say a square foot, perpendicular to the solar beam at the surface

of the earth, is determined. But this quantity is not all that would be given to the same surface were the atmosphere removed, or if the same experiment were made at the outer limits of the aerial covering of the globe. A portion of the heat is absorbed and another portion reflected from the atoms in its passage through the air, and, in the solution of the problem under consideration, it became necessary to know the amount of loss from this cause. To ascertain this, the experiment was made while the sun was on the meridian and at different degrees of elevation, even down to near the horizon. The diameter of the earth, the approximate height of the atmosphere, or the length of the column of air traversed by the ray which passes from the zenith, and also the angle of elevation of the sun, being given, the lengths of the several lines through the atmosphere traversed by the respective rays were readily calculated; and if we suppose that the amount of heat received at the outer limit of the atmosphere is invariable, it is not difficult to determine the part which is absorbed. The numbers obtained by observation consisted of two quantities, a constant and a variable one; the former being the heat of the sun, and the latter the amount absorbed in passing through the different lengths of atmosphere.

From these data, the amount of heat received from the sun on a square centimetre at the limit of the atmosphere, and which it would equally receive at the surface of the earth, if the air did not absorb or reflect any of the incident rays, was ascertained to be 17,633 units of heat in one minute of time. It was also found that the atmospheric absorption of the rays directly from the zenith was comprised between eighteen and twenty-five-hundredths of the whole, even in cases where the sky was perfectly clear.

After having ascertained the quantity of heat which the sun sends to the earth during one minute of time, by its perpendicular action, on one centimetre, it was not difficult to ascertain the total quantity of heat received by the whole illuminated hemisphere in the same time. Indeed, this quantity is nearly the same as that which would fall on the plane of a great circle of the earth. From this can be readily deduced the amount of heat which would fall upon the earth during a year; and this was determined to be 231,675 units falling on each square centimetre of surface which limits the atmosphere. Calculating the amount of ice which this quantity of heat would melt, the following result was obtained, namely, a thickness of 30.89 metres, or a little more than

101 feet:

that is, if the total quantity of heat which the earth receives from the sun in the course of a year were uniformly distributed over all points of the globe, and were employed without loss in dissolving ice, it would melt a stratum which would have the above thickness.

The data given by these experiments enabled the author to solve another problem, which would appear even of a more transcendental character. This consisted in determining the amount of heat given off by the whole surface of the sun in a given time. For this pur-

pose, it was only necessary to consider the sun as the centre of a spherical enclosure, the radius of which is the distance from the earth to the sun; and it must be evident that in each square centimetre of the concave surface of this vast sphere is received during each minute of time as much heat as is received during the same space of time on a square centimetre at the surface of the earth. If, then, the number 17,633, before obtained, is multiplied by the number of square centimetres in this spherical surface, the absolute quantity of heat given off by the sun during a given time will be ascertained. The number expressing this quantity for each minute of time is

84,888 thermal units.

If this quantity of heat emitted by the sun were exclusively employed in dissolving a stratum of ice, applied to the solar surface, and enveloping it on every side, it would melt in one minute a stratum of

11.8 metres thick;

and in one day a stratum of 16,992 metres, or

$10\frac{1}{2}$ miles.

These results cannot be considered more than approximations, though, in the progress of science, they may be rendered much more precise, and may be applied to solve many problems relative to the physical phenomena of the earth and our solar system.

Original heat of the earth.—Besides the smaller influence of celestial space, and the governing one of the emations from the sun, there is another source of terrestrial heat, which, though it at present produces scarcely an appreciable effect upon the temperature of the surface, was once powerfully active in effecting geological changes, and in so modifying the surface of our planet as to give rise to the diversities of surface constituting mountains, seas, and continents, which now determine the varieties and peculiarities of our present climates, and may in the future be of vast practical value in its applicability to the wants of life. We allude to the internal heat of the earth.

That the earth was once at least in a liquid condition by heat, can scarcely be doubted, when all the cumulative evidence in favor of the hypothesis is considered.

First. Self-luminous bodies are met with in every part of the visible universe, and if we follow the strict inductive process, allowing no more causes than are true and sufficient, we must admit these bodies are intensely heated. It is, therefore, not impossible that the earth itself may have been at one time a self-luminous star.

Second. The surface of our moon, though it now gives no indications of heat except of the lowest temperature, when viewed through a powerful telescope appears almost covered with the craters of extinct volcanoes; and hence we may infer that it has cooled down from a high temperature to its present condition.

Third. Every portion of the earth's crust exhibits the remains of igneous action, and the facts of geology are inexplicable on any other hypothesis than that of the past high temperature of our globe.

Fourth. On every part of the earth's surface where the experiment has been made, starting from the point where the sun's influence

ceases, there has been found an increase of temperature as we descend toward the centre, at the rate of about a degree for every fifty feet.

Fifth. On different parts of the earth's surface springs of hot water are found bursting forth.

Sixth. There are on the surface of the earth several hundred volcanoes, which occasionally emit heated materials. and, in some cases, ignited lava.

Seventh. The oblate form of the earth is on an average that which would be due to the rotation of a liquid mass.

From all these facts we may safely now admit the hypothesis, which was at first a mere antecedent probability, as a definite theory, namely, that the earth was at one time in a highly heated state, and that its interior, even at the present moment, is still at a very elevated temperature. If we apply this hypothesis to the facts of geology as they are generalized and arranged at the present day, we have a complete explanation of the whole; or if there be any outstanding phenomena not yet included in this generalization, their number is so small in comparison to those included in it, that they may reasonably be left for the present until further discovery shall throw more light upon their character. The great principle of universal gravitation was not abandoned, though at one time several facts in regard to the motion of the moon could not be referred to it. The same consideration applies to moral subjects as well as to those of science.

EQUILIBRIUM OF THE ATMOSPHERE.

The aerial covering which surrounds our earth may be compared to an ocean, of which the bottom is composed of land and water, which has a definite surface above, probably agitated by tidal waves of great extent and magnitude. Although nearly eight hundred times lighter than water at the surface of the earth, yet it possesses a very appreciable weight, since a cubic yard of it weighs about two pounds, and consequently, when moving with high velocities, it produces great mechanical effects upon bodies subjected to its momentum.

This ocean, unlike the aqueous ones belonging to our earth, diminishes in density very rapidly as we ascend, and finds its limit at that elevation, at which the repulsion of the last layer of atoms added to the centrifugal force of the earth's rotation is just balanced by the attraction of gravitation. In order to simplify the conditions, and to give precise ideas of the mechanical equilibrium of the atmosphere, we will at first suppose it to be a body consisting of simple atoms, which, though they obey the attraction of the earth, repel each other. This repulsion increases, as we have said in our exposition of the atomic theory, with a diminution of the distance of the atoms—a fact which may, perhaps, be best illustrated by a portion of air confined by a movable piston in a tube closed at the bottom, as in the case of the ordinary fire syringe, the well known instrument used for igniting tinder by means of the condensation of a portion of air. If such an instrument be placed under the receiver of an air-pump, and

the pressure of the atmosphere be removed from it, the air which is contained under the piston will expand; and if the tube be sufficiently large, this expansion will continue until the repulsive energy of the atoms under the piston is just equal to the weight of the piston itself. If we now double the weight of the piston, it will descend until the air is compressed into half its first volume. At this point, a new equilibrium will take place between the weight of the piston and the repulsive energy of the atoms. If, again, another addition be made to the weight of the piston, it will descend through another distance, and in all cases the compression will be inversely proportioned to the weight applied; but the density of the air, that is, the weight for a given quantity, increases as the bulk diminishes, and therefore, in all cases of a gas, the density or the number of ponderable atoms in a given space will be inversely proportioned to the pressure applied.

This fact was discovered independently by an English and a French philosopher, and is generally known by the name of the discoverers, namely, the law of Boyle and Mariotte, but perhaps more frequently it bears the name of the latter.

The same law applies to all other gases within certain ranges. In the case of atmospheric air, within the limit of experiment it appears to hold without variation, or, if any, with a very minute one, when great pressure is applied in connection with a great reduction of temperature. In the case of carbonic acid, the range of distance of atoms is much less in which this law is found; for, by mechanical pressure, the gas is converted into a liquid, a sudden change taking place in the intensity of the repulsion of the atoms at this point. Vapor of water, separated from the liquid which produced it, obeys the same law as that of air; but in this instance the range of atoms is still more limited than that of carbonic acid, and with a slight pressure, and at the ordinary temperature of the atmosphere, the vapor is converted into a liquid.

The atmosphere being subject to the law of Mariotte, we shall now proceed to inquire what will be its condition of equilibrium or rest.

First. If we suppose the whole atmosphere surrounding the earth to be divided into a series of strata of equal weight, as thin as may be necessary, and separated by ideal surfaces perpendicular to the plumb line, these surfaces will rest upon each other, and be in a state of equilibrium when each part of the same stratum is of the same density.

Second. In order to a stable equilibrium, the density of each stratum must diminish from below upwards.

Third. The upper stratum must be below the point where the centrifugal force, derived from the rotation of the earth, becomes equal to the weight of the air at this point.

If the first condition is not fulfilled, that is, the equality of the density of the strata the same at all points, the heavier parts will flow below those which are less dense, and buoy them up in the same manner as the heavier liquid sinks below the lighter one; and it is evident that if the upper strata were heavier than the lower ones. an

unstable equilibrium would be produced, which the slightest agitation would overthrow.

Lastly, if the atmosphere extended upwards above the point where the centrifugal force equalled the weight of the gas, the whole atmosphere, strange as it may appear, would fly off into void space. To explain this, it is necessary previously to demonstrate the important though paradoxical fact which results as a logical consequence of the law of Mariotte, that the total height of an atmosphere surrounding a planet does not depend upon the quantity of gas of which it is constituted. To prove this, let us imagine a vertical column, say an inch square at the base, filled with air of a given density extending to the top of the atmosphere. Let us suppose this column to be divided into portions an inch high throughout its whole length by movable planes, and into each one of these portions double the quantity of air to be introduced. The lowest portion, namely, the first inch, will not be enlarged by this condition; for though twice as many repellant atoms are introduced into the same space, tending to repel upwards the first dividing plane, yet this plane will be pressed downward by twice the weight, because twice the number of atoms have been introduced into all the strata above.

The same reasoning may be applied to all the successive strata until we come to the very highest. On this no additional weight is placed, and it would therefore expand until the diminution of its elasticity just equals its own weight, and at this point the equilibrium will take place. If, however, this point should be just at the place of equilibrium where the weight of the atom would be overcome by the centrifugal force, the upper film would be removed, another would expand into its place, and another, and another, until the whole atmosphere would be withdrawn. This, as we have said, is a logical consequence of the extension of the law of Mariotte, and has been applied by Dalton and others to determine the heights of mixed atmospheres, or of atmospheres of different densities. But the height of the atmosphere is probably far below the point where the weight of the atom is equal to the force of gravity, since this may be found by calculation to be at about 5.6 times the earth's radius from the surface at the equator, or about 22,400 miles. If we suppose the column to be formed of a lighter gas, as for example hydrogen, the atoms of which have the same repulsive energy as those of air, then the column will be inversely proportioned to the density at the surface, and from this we can readily calculate the relative heights of atmospheres of different gases, having different densities at the surface of the earth. These heights will evidently be inversely as the densities, or, in other words, the specific gravities, of the same gases under the same pressure. If the specific gravity of hydrogen be represented by 1, that of nitrogen in round numbers will be 15, that of oxygen 16, and that of carbonic acid 22, and the total heights of atmospheres of these gases will be inversely as these numbers; or if we call the height of an atmosphere of oxygen 60, then the heights of atmosphere of these gases will be as follows :

Gases.	Specific gravity.	Height of atmospheres, oxygen being 60 miles.
Hydrogen	1	960
Nitrogen	15	64
Oxygen	16	60
Carbonic acid	22	44

In the foregoing the repulsive energy has been considered as increasing in conformity with the law of Mariotte, directly as the pressure and without regard to the increase of repulsion caused by heat; but if we suppose that the repulsion of the atoms of the lower stratum is increased by heat, they will be separated further apart, and the space occupied by them enlarged. But if the heat extends upwards through the whole, each of its parts will be uniformly expanded, and hence the relative height of atmospheres of different grades will not be altered by an increase of heat, provided this increase is the same in each gas. The absolute heights will, however, be increased $\frac{1}{490}$ part for each degree of Fahrenheit's scale above its volume at the freezing point.

In order to obtain or determine an equilibrium of the atmosphere when the natural repulsion of the atoms is increased by heat, each stratum as we ascend must at least contain the same amount of caloric. In this case, if a quantity of air be removed from a lower to a higher position, it will expand on account of the reduced pressure, and the same amount of heat being now diffused through a larger space, the intensity of its action or its temperature will fall, and thus a reduction of sensible heat will be observed as we ascend in the atmosphere. The equilibrium we have described would not, however, be a stable one, and hence the upper strata of the atmosphere contain more heat per pound than the lower.

Until about the middle of the last century, the atmosphere was supposed to consist of one simple homogeneous substance, and after modern chemistry had discovered it to be a compound, the ingredients were thought to be chemically united. It was also supposed, until the researches of Dalton proved the contrary, that the vapor of water found in the atmosphere was dissolved in it, as one liquid is dissolved in another.

Dalton was the first to advance the proposition that the atoms of different gases neither attract nor repel each other; and though each offers a slight mechanical obstruction to the free motion of the other, yet, if sufficient time be allowed, each will arrange itself as if the other did not exist; or, in other words, while the atoms of the same gas repel one another, those of different gases exert no action of this kind, and are in fact statical though not dynamical vacuums each to the other. The fundamental fact upon which this theory is based is the following: If, for instance, two wide-mouthed jars be placed, one on the other, mouth to mouth, the lower one being filled with oxygen or heavy gas, and the upper one with hydrogen, the lightest of all

gases, and thus suffered to remain, after a short time it will be found that the two gases will be thoroughly mingled through both jars; the light gas will descend and mix with the heavier, while, in turn, the heavier will ascend and mix with the lighter. There will be no increase or diminution of bulk of the two gases after they have thus mingled. In order to explain the mixing of gases, three hypotheses may be assumed:

First. We may suppose that the atoms have an affinity for each other in their gaseous state. But if this were the case, from general analogy there should be a diminution of the bulk; the number of centres of repulsion would be diminished, and also the intensity of the action of each would be at least partly neutralized.

Secondly, we may suppose that the two classes of atoms repelled each other, but in this case no mixture could take place; the heavier gas would remain in the lower vessel, while the lighter one would occupy the upper position.

Thirdly. If we suppose the atoms of the two gases have no action on each other, but are free to obey their own repulsions, then the atoms of each gas will expand into the void space of the interstices of the other, and the diffusion indicated by experiment will be produced.

It follows from this hypothesis that the bulk of the mixture should remain the same before and after the mingling takes place. Let us suppose each vessel to contain a foot of gas, and that the repulsive energy is sufficient to sustain a weight of 15 pounds to the square inch; and let us suppose the interior of the vessel containing the hydrogen is a vacuum. Then it is evident that the oxygen in the lower vessel, being relieved from the pressure of the atmosphere, will expand and fill both vessels, and, by the law of Mariotte, its elastic force or repulsive energy will be reduced to one-half or $7\frac{1}{2}$ pounds to the square inch. The same will take place with regard to the hydrogen. It will expand downward and fill both vessels, and its elastic force will be reduced to one-half or to $7\frac{1}{2}$ pounds to the square inch. If, therefore, the gases are vacuums to each other, they will each expand into the other and form a mixture of two gases, the pressure of each of which against the sides of the vessel will be $7\frac{1}{2}$ pounds to the square inch, and consequently the whole pressure will be 15 pounds.

The theory of Dalton is in exact accordance with all the facts, though it may be difficult to conceive of atoms, such as those of oxygen and hydrogen, as being without action on each other, particularly when highly compressed. Indeed, Mr. Dalton, in the latter part of his life was inclined to refer this seeming want of repulsion to the fact of the different sizes of the atoms, or, in other words, to the difference in the spheres of their repulsive energies. If two classes of atoms were thus mingled with each other, it is evident that they could not be in equilibrium until the one was generally diffused through the other; this would give a ready explanation of the diffusion of the two gases through each other in close vessels. But it does not seem to us to be applicable to the explanation of free atmospheres coexisting on the surface of the earth, as appears to be the case, particularly with reference to the gases and aqueous vapor of the atmosphere.

I have dwelt upon this point because very erroneous ideas are frequently entertained as to the theory of Dalton, which, whatever may be its truth, has had a very important bearing on the progress of meteorology. By one class of writers on the subject it has been the basis of all investigation, and by another it has been too much neglected. All our hygrometrical calculations relative to the amount of water in the air rest upon it. While there remains but little doubt that if the air, as a whole, were at rest. and sufficient time were given for the establishment of an equilibrium, the several ingredients would arrange themselves in accordance with this theory; yet since the atmosphere is constantly agitated with currents, and diffusion is carried on more rapidly through this agency than that from the self-repulsion of the atoms, we can only suppose, particularly in the lower strata of the atmosphere, that there is merely a constant tendency to assume the statical condition indicated by the theory.

COMPOSITION OF THE ATMOSPHERE.

At the level of the sea and at all accessible heights our atmosphere principally consists of nearly an invariable mixture of two permanent gases, oxygen and nitrogen, and a number of other variable substances, of which we enumerate carbonic acid, nitric acid, ammonia, hydrogen, mineral powders, animal and vegetable matter, odoriferous substances, and, above all, a considerable quantity of water in a state of invisible vapor, and that of partial condensation in the form of cloud. Indeed, it must be a reservoir of all the emanations which arise from the decomposition of animal and vegetable matter, and which are given off from all substances in minute quantities under the application of heat. Though the variable portions of the atmosphere form but a small per-centage of the whole mass, yet they exert an important influence on animal and vegetable life, and deserve the special attention of the agricultural chemist.

Analysis of the air.—But, before proceeding to give an account of these, it may be well to pause here for a moment to describe the simplest method by which the constitution of the air may be approximately analyzed. For this purpose, we introduce into a large glass vessel filled with ordinary air a small quantity of limpid lime water, or, better still, baryta water, and having closed the vessel agitate the liquid. All the soluble substances, including the carbonic acid, will be absorbed. The latter will unite with the lime or baryta water and form insoluble carbonates, which may afterwards be separated from the water, dried and weighed, and the amount of carbonic acid thus determined. To obtain the amount of vapor in a given quantity of air, the latter is drawn through a tube containing chloride of lime, a substance which has a great affinity for moisture. The increase of weight found after the process will indicate the amount of water in the portion of air submitted to the experiment. The volume of this air may be readily ascertained by attaching the tube containing the chloride of lime to the upper part of a vessel, say of a cubic foot in capacity, filled with water, from which the liquid is suffered to run

out by an orifice at the bottom; an equal bulk of air will enter through the tube containing the chloride, and when all the water has run out, the vessel will be filled with air, or, in other words, one cubic foot of the moist atmosphere will have passed through the drying tube. The quantity of aqueous vapor is more variable than that of the carbonic acid.

After having separated the water and carbonic acid, in order to ascertain the amount of oxygen and nitrogen in a cubic foot of air, we burn in the mixture a piece of phosphorous, which combines with every atom of the oxygen, forming a soluble substance called phosphoric acid, which is absorbed by the water, leaving the nitrogen in a separate state. Other and more refined methods are frequently employed, but this will serve to indicate in a general way, the mode in which the results are obtained. In this manner, we find that the atmosphere consists of 20.01 parts of oxygen to 75.29 of nitrogen in volume, or 23.01 parts, by weight, of oxygen and 76.9 of nitrogen. These numbers are not precisely those which would result from a chemical union, as was at first supposed, namely, one volume of oxygen and four of nitrogen. They are not also entirely invariable, but are found slightly to differ at different places at the level of the sea. Observation has not shown any appreciable variation from year to year, though it is not improbable that during the geological periods changes have taken place in its proportions as well as in its amount. The quantity of carbonic acid is found, by the mode we have described, to vary from the $\frac{4}{1000}$th to $\frac{6}{1000}$ of the weight of the whole.

Oxygen, as we have seen in the exposition of the atomic theory, is a very energetic element widely diffused through Nature, and performs an important part in the transformations of inert matter into plants and animals, and back again into carbonic and other inorganic compounds. The nitrogen also is an important element in vital economy, and is associated with all the most instable organic compounds. Its atoms appear to exert a great repulsive energy on each other; and hence, when confined in a solid state by surrounding atoms of other substances, the slightest jar will overturn the instable equilibrium, and produce a violent explosion.

Carbonic acid is a transparent substance that is produced when charcoal is burnt in air or oxygen, and is composed of one atom of the former to two of the latter, or three parts of the one to eight of the other by weight. It furnishes the carbon of the plant, and though it exists in small quantities in the atmosphere, animal and vegetable life could not be continued on the surface of the globe without it. The quantity of carbonic acid contained in the air varies between the hours of night and day, the quantity being at its maximum towards morning, and its minimum towards the middle of the day. In this respect, it follows a law analogous to that of the heat and moisture of the atmosphere. A part of this variation may be referred to the absorption of carbonic acid by plants during the day, though this cannot be the principal cause; a more efficient one is probably the varying quantity of moisture, which may serve as a kind of vehicle for its transportation to and from the ground. There is

also a great difference in the amount of carbonic acid in different places, perhaps in different countries, and it is possible that a part of the variations of fertility, the other conditions being the same, may in some cases be referred to this cause. We find, from experiment, that vegetation is favored by the increase of this ingredient until, according to Saussure, we arrive at the proportion of eight parts to one hundred, which is eighty times more than the ordinary quantity existing in the atmosphere. The same portion would entirely extinguish the life of the red-blooded air-breathing animals. It is on this fact that some geologists have founded the hypothesis that the luxuriant vegetation which existed on the earth during the coal period was due to an atmosphere charged with carbonic acid, and the amphibious character of the animals existing at that period would seem to favor this supposition.

M. Chevandier has shown that one square mile of forest land produces annually 441 tons of fixed carbon in the wood, (Compte Rendus,) and Liebig increases the quantity to as much as 504 tons to the square mile. The same author also shows that all other vegetable productions yield nearly the same quantity of carbon to the square mile. Now, a prism of air extending to the upper limits of the atmosphere, and having a base of one square mile, contains 4,260 tons of carbon, whence it results that the annual consumption of carbon by thrifty vegetation amounts to about one-ninth of all the carbon of the atmosphere which rests upon it.—*Gasparin, vol.* 2.

From this, at first sight, it might appear that the carbonic acid of the air ought rapidly to diminish, and in a few years to be entirely exhausted; but, as we have seen, the carbon thus extracted is not lost to the air, but lent, as it were, to the organized matter of the globe; for by the process of combustion and decay an equal amount of the same substance is restored to supply the place of that previously abstracted, and the whole quantity of carbon in the atmosphere remains nearly the same from age to age, the measurable variations being only perceptible during the lapse of the ages which constitute a geological period. When we consider, however, the great amount of coal consumed at the present day in the mechanical arts and locomotion, it would appear that the amount of carbonic acid is increasing in the atmosphere; but when we compare with this the improvements made in agriculture, and the stimulus thus afforded to the growth of plants and animals, the effects of these artificial conditions would apparently nearly balance each other. There is another source of abstraction of carbonic acid from the atmosphere, namely, that which takes place through the agency of animal life in the production of coral; but this again may be probably balanced by the carbonic acid emitted from the various active volcanoes of the globe. We do not, however, by these remarks attempt to establish the fact that in all parts of Nature there is an exact compensation, and that our globe has always remained in the state in which it now exists, but that the great changes which affect our planet are exceedingly gradual, and the conditions may be considered constant during the age of individuals, or even of nations.

Should the carbonic acid of the air sensibly increase with the limits before mentioned, the vegetation of the earth would, as we have seen, become more luxuriant, and animal life degenerate into a lower type. If, on the other hand, the carbonic acid should be diminished, the reverse would probably take place, vegetable life would become less, and animals either correspondingly diminished in number, or would assume a higher type. M. Floriens supposes that the amount of organic life on the surface of the globe has remained the same through all periods, though exhibited under different forms, but this would be dependent upon the permanency of the amount of organizing force from the sun.

Saline matter.—The air which passes from the surface of the ocean contains a portion of the saline ingredients which produce in positions near the sea, and in some cases further inland, a marked effect upon the character and condition of vegetation. Dr. Dalton found, at Manchester, one part of salt in one thousand parts of rain water. Brandes found in rain water, in Germany, besides common salt, chlorate of magnesia, sulphate of magnesia, carbonate of magnesia, chlorate of potassium, sulphate of lime, oxide of iron, oxide of magnesia, and salts of ammonia, the greatest part of these being ingredients of sea-water. This explains the fact that certain plants do not grow luxuriantly near the ocean unless screened by a fringe of trees or houses, or protected in some other way. Near the ocean, a number of garden plants cannot be made to grow unless placed near a fence which intercepts the wind from the ocean. We might infer from this that the saline matter is carried mechanically by the air, and not diffused through it, as in the case of vapor. We are informed by Mr. Browne that a gentleman at Nahant has succeeded in raising pears to perfection by protecting the trees on the ocean side by a high brick wall, perforated at intervals with comparatively small openings, sufficient, however, to keep up the ventilation.

Mineral matter in the atmosphere.—There is also constantly diffused through the air a considerable quantity of mineral substances, in a state of impalpable powder. This is carried up by the ascending columns of air which are constantly arising under the varying heat of the different portions of the ground due to the influence of clouds and the various conditions of the surface, and it is brought down in the rain which falls in the beginning of a shower. The presence of this material is, at all times, rendered evident when a ray of light enters a small hole in the window shutter of a darkened room. By ome, it has even been conceived to be an essential ingredient of the atmosphere. The amount of this is much greater than we might be led, by casual observation, to suppose. It falls upon the decks of vessels in mid-ocean, and forms dry clouds, which were observed by Prof. Piazzi Smyth, at the height of several thousand feet, upon the side of the Peak of Teneriffe.

Its constant prevalence in the atmosphere furnishes an explanation of the presence, in the composition of certain plants, of a minute quantity of mineral matter, which is not found in the soil in which they grow.

Pollen of plants.—At certain seasons of the year, the pollen of the pine tree and other plants is carried to immense distances, and, after a thunder-storm, is often found on the surface of water in our rain casks, and, from its yellow color, is frequently mistaken for sulphur.

Ozone.—Another substance, which, of late years, has been discovered in the atmosphere by the indefatigable labors of Prof. Schönbein, the inventor of gun-cotton, is known by the name of "ozone," which is supposed, from all the researches made upon it, to be oxygen in a peculiar condition, in which its affinity for other substances or combining power is highly exalted. When a stream of frictional electricity is made to flow from the point of the prime conductor of an ordinary machine, a peculiar odor is perceived, due, as is supposed, to the oxygen of the air assuming an altered condition, and hence it has been inferred that ozone consists of oxygen with an extra dose of electricity.

M. Clausius, however, has advanced another hypothesis, which appears to be in accordance with other facts, namely, that an ordinary atom of oxygen, of which the atomic weight is eight, is in reality a molecule composed of two atoms, and that under the influence of electrical repulsion these atoms are separated, and in the unneutralized affinity, consequent upon this separation, the increased avidity of combination is evinced.

Whatever be the nature of ozone, it is certain it possesses great powers of combination with many other substances, and thus tends to produce chemical effects. It is probably produced on a large scale in the atmosphere, on the same principle by which it is obtained in the laboratory, namely, by the electrical discharge in the form of lightning from the clouds.

The test for ozone consists of one part of iodide of potassium, ten parts of starch, and one hundred parts of water, boiled together for a few minutes. A thin coating of this preparation applied to writing-paper with a brush, being exposed to an atmosphere containing ozone, is rendered blue from the evolution of the iodine. In order to bring out the blue color distinctly, it is necessary to dip the paper in pure water.

Besides the action of the electrical spark, ozone may be produced by the action of phosphorus on atmospheric air, provided moisture is present. It is also produced in the gas evolved in the galvanic decomposition of water. But by whatever process obtained, it always presents the following properties:

First. It is a gaseous body of a very peculiar odor, approaching that of chlorine when intense; when diluted, it cannot be distinguished from what is called the electrical odor.

Second. Atmospheric air strongly charged with it renders respiration difficult, causes unpleasant sensations, and by its action on the mucous membrane produces catarrhal affections. It soon kills small animals, and, undiluted, must be highly deleterious to the animal economy.

Third. It is insoluble in water.

Fourth. It is a powerful electro-motive substance.

Fifth. It discharges vegetable colors.

Sixth. At common and even low temperatures, it acts powerfully upon metals, producing the highest degree of oxidization of which they are susceptible.

Seventh. It destroys many hydrogenated gaseous compounds.

Eighth. It produces oxidizing effects upon most organic substances.

But the question regarding it, of the greatest general interest, is a physiological one. It is not found in places abounding in miasma, and from its energetic powers of combination, it is thought to decompose the organic molecules, of which this effluvium is supposed to consist, and hence observations in regard to it are highly desirable.

Dr. Smallwood, near Montreal, who has made an extended series of observations upon ozone, concludes that its presence in the air does not depend upon temperature but moisture. He has observed traces of it when the thermometer was at 20° below and at 80° above zero. But in general it was present in large quantities during the fall of rain and snow, which may account for its greater prevalence near the sea shore than elsewhere. It appears to exist in great quantities in dew, and to this fact has been attributed the remarkable rusting effect produced on iron when exposed to this form of precipitation of water.

Malaria, or miasma.—In certain places, there is diffused through the air an exceedingly minute quantity of a substance which has a powerful effect on the human system, and frequently offers in such districts a serious obstacle to the cultivation of the soil. It is this which gives rise to intermittent fevers and perhaps to maladies of a more malignant character. This substance is found in marshy and low places where animal and vegetable matter of an aqueous character is in a state of decomposition, but the winds which pass over these places transport the malarious effluvia to a distance and thus render whole tracts of country unhealthy.

The corpuscules of this substance appear to adhere to the molecules of water, and are elevated with the latter by the ascending currents of air to heights which vary in different countries. Around the Pontine marshes, in Italy, the malaria disappears at the height of from seven hundred to one thousand feet, while in South America, according to Humboldt, it is found at an elevation of three thousand feet; usually, however, its effects are exhibited with intensity at a much lower elevation than that first mentioned. It is also observed that humid air, which transports miasma, is deprived of this noxious material in passing through trees, and that in many cases, in the same neighborhood, a screen of foliage is sufficient to produce a marked difference between two places otherwise similarly situated. Double screens of fine gauze also placed in the windows of sleeping rooms answer a similar purpose, and should be resorted to in all cases as a precaution wherever there is danger of disease from this cause. It is probable that the diffusion of malaria in still air, as in the case of vapor, is exceedingly slow, and hence anything that tends to interrupt the current will much retard its transmission. It is asserted that in some cases near the focus of emanation it is less

deleterious than at places at a considerable distance. It would appear from this to ascend vertically with the columns of heated air and to be afterwards wafted horizontally to a distance, and there impinging on the first elevation produces its effects; or perhaps this opinion has arisen from the screening influence of objects near the source.

Miasma in perfectly dry air is in such small quantities as not only to be inaccessible to the investigation of science, but also insufficient seriously to affect human life. It is otherwise, however, in air cooled by the radiation of the evening and night. It appears then to be precipitated into the lower strata of the atmosphere with the mass of humidity with which it seems to be connected, and when this is evaporated again at sun rise, it carries up with it the miasma in its ascentional movement. At this time it is taken into the system by swallowing, respiration, and perhaps by absorption through the pores of the skin, in sufficient quantities to manifest its deleterious effects. In malarious districts, therefore, caution should be taken against exposure to the evening precipitations and morning evaporation of the humidity of the atmosphere. Ground which has been a long time under water retains during a series of years the property of emitting the effluvia. The virgin soil in which decaying vegetable matter has accumulated for years, when first exposed to the action of the air by the labor of the pioneer, gives off a large amount of malarious effluvia; care should therefore be taken in the new settlement of a country not only to select a proper location, but also to protect the houses by a border of trees, particularly on the side against which the prevailing wind impinges. And it is to be regretted that good taste, as well as the comfort of an agreeable shade, does not more frequently induce the husbandman to spare some of the original products of the forest which are found near the spot on which he erects his dwelling. It is also stated that plants in active vegetation, as in the case of sunflowers, absorb deleterious effluvia; but whether this effect is produced independently of the screening we have mentioned has not yet been settled. In the fertile regions of the tropics where heat and moisture abound—for example, the valley of the Amazon—and where vegetation is luxuriant, the malarious effluvia is at its maximum; while in dry countries with less vegetable life, such as those west of the Mississippi, it is not found. Nature thus is not indiscriminately benevolent to civilized man; in his uncivilized condition different races are confined to different districts, and the influences which affect one are inoperative on the other. It is only by investigating the causes of these differences, and thus in some cases arriving at the means of controlling them, that the civilized man becomes a citizen of the world, and within certain limits is enabled to overcome the natural enemies to which in his primitive ignorance he is exposed.

The difficulty of investigating the nature of miasma has induced some to believe its effects due to variations of temperature and moisture; but this is not sufficient to explain all the phenomena, as places very different in this respect vary greatly in their sanitary

condition. The quantity of material (whatever it may be) which constitutes malaria is too minute to be immediately detected by the eudiometer, the instrument usually employed to analyze air. M. Moscati, in order to collect it in considerable quantities, employed a glass globe filled with ice, on the surface of which the aqueous vapor of the atmosphere was constantly precipitated. He found that the water thus collected in infected places was of a white color, inodorous, slightly alkaline, and after standing a short time lime-water and acetate of lead produced in it a light precipitate. It contained animal matter, ammonia, and chlorate and carbonate of soda. The effect of this water upon animals has not, so far as we know, been tested, though it is said that sheep which feed upon grass covered by the morning dew in infected districts are subject to peculiar maladies.

The presence of organic matter may be detected in the process just described by dropping into the water a little sulphuric acid, and by afterwards evaporating the fluid we will obtain traces of carbon. If the experiment, for example, be made in a slaughter-house, comparatively a large amount of this substance will be obtained; and yet from abundant observation it is known that the animal effluvia to which the butcher is constantly exposed is not of a morbific character, since the followers of this occupation are proverbially healthy. It would appear from this fact that the hurtful miasma is of vegetable, not of animal origin. That collected by Regaud had the odor of burnt plants when incinerated. The same investigator asserts that a marshy odor does not always indicate feverish infection, and that in malarious districts it was above all to be feared at times when the air appeared pure and inodorous. From all the facts, then, it appears most probable that the substance called miasma is an organized body, endowed with life, and first generated in the decomposition of aquatic vegetation; that its introduction into the circulation of animals is a real innoculation affecting especially the nervous system; finally, that when it commences itself to decay in the open air, it ceases to be deleterious, though it gives rise to disagreeable odors. This investigation opens a wide field for chemical research, to which the later improvements in the art of analysis may perhaps be successfully applied. Whatever may be the cause of the disease spoken of, experience has indicated the following precautions for those exposed to its influence:

1st. In malarious districts avoid as much as possible going out before the dew has evaporated.

2d. Do not go out fasting, but before exposure to the morning air take some slightly exciting drink, such as coffee or tea, in place of spirits. The former produces a healthful exhilaration, which prevents an attack of the miasma, while the reaction which succeeds the exhilarating effects of the latter tends to favor the absorption of the poison.

3d. Wear flannel garments next the body, which tend to stimulate the skin and prevent the deleterious effect.

4th. The use of disinfectants, though perhaps less energetic in destroying miasma than in decomposing odors, should not be entirely neglected; and for this purpose, a small quantity of chloride of lime

may be carried about the person. It is said the flashing of gunpowder in a room answers the same purpose.

5th. Screens of trees should be planted to interrupt the damp and warm wind from the focus of the emanation.

6th. During warm weather, when ventilation is more necessary, provide the doors and windows with screens of fine gauze.

7th. Use boiled water in preference to any other, or pure rain water, or that which has fallen some time after the rain commences, to which add a small portion of vinegar or acetic acid.

8th. In cool evenings of summer, the dampness of the house should be dissipated by a blazing fire upon the hearth.

It appears that the malarious influence is produced at a certain temperature, and that it is favored in marshy places by the heating of the water in shallow pools. It has been recommended to divide such places by deep parallel ditches or narrow canals at right angles to the direction of the prevailing wind, the earth of which is to be thrown up on the side in the form of dykes, which are to be planted with rapidly growing trees or large shrubs. The ditch collects the water in too large bodies to be much heated, and this effect is further lessened by the shade of the trees. The latter also serve as a series of screens to intercept any malaria which may arise.

Nitric Acid.—If sparks of electricity are passed through a tube containing atmospheric air, the oxygen and nitrogen, which do not combine under ordinary circumstances, will chemically unite and form nitric acid. This union is supposed to be the result of the production of ozonized oxygen, which unites itself with the nitrogen on account of its increased combining energy. The nitric acid, thus formed, combines with the ammonia, which is also found in the atmosphere as an original though a variable constituent, and forms nitrate of ammonia. To the atmosphere is also probably due the nitric acid which forms the nitrate of lime, from which the nitrate of potash, the principal ingredient of gunpowder, is reached from the soil containing the base. We have in this instance another confirmation of the conservation and transformation of power. The discharge of the electricity in the heavens expends a portion of its energy in producing a change in the condition of oxygen, which, in its turn, attracts and imprisons, as it were, a portion of nitrogen—a substance which, of all others, appears to possess the greatest repulsive energy, and the violent breaking loose again of this from its combination exhibits its power in the explosion which ensues. In this way, as it were, the bolt of Jove may be said to be transformed into that of Mars, and the thunder of war to be but a reverberation of that of the heavens. The same result is produced on a large scale in the atmosphere by the discharges of lightning.

Odors.—The observations which have been made during the photographic process have revealed the fact of the existence in the air of the vapors of metals and other substances, which, though so minute as to have escaped particular attention, are yet sufficient to interfere materially with the operations necessary to the production

of perfect pictures. Almost all metals heated to redness give off effluvia perceptible by the sense of smell.

The diffusion in the air of the odoriferous principle of plants and other substances is a subject worthy of more attention than it has yet received. The wide diffusion of an almost infinitesimal quantity of matter in these cases may well excite our astonishment. A single grain of musk has been known to scent a room for twenty years; and, in order to this result, the minuteness of the atoms must be beyond the conception of the imagination. From the influence which chlorine has upon animal and vegetable odors, it is probable that hydrogen is an essential part of their composition. The atmosphere itself, when pure, is inodorous; but the absence of perceptible odor may be due to the fact that our sense of smell ceases in some cases to indicate an odor after having been for a certain time subjected to its influence; for example, the nauseous effluvia which arises in some process of the arts becomes often insensible to the operator, and the same may be said in regard to the effect of animal effluvia on the inmates of crowded and ill-ventilated houses. The sense of smell, like our moral faculties, thus becomes blunted by misuse or improper association.

Matter in the aeriform condition is generally transparent, though different gases exhibit occasionally different colors; even the atmosphere possesses this property in a slight degree, as is evident in the fact of the slightly blue appearance of distant objects.

> 'Tis this that "lends enchantment to the view,
> "And robes the mountain in its azure hue."

From all that we have said, it appears that the aerial ocean, like the aqueous one, is a vast reservoir, principally composed of two ingredients of nearly constant proportions, and a number of adventitious materials, which, in some cases, though in very minute quantities, have a marked influence on animal and vegetable life. There is, however, another variable ingredient, to which we have alluded in a general way, which, by its production and condensation, is the agent to which nearly all the fitful variations in our atmosphere are to be ascribed. I allude to the aqueous vapor of the atmosphere. But, before proceeding to consider this, it will be necessary to treat more fully of some of the principles of heat and its influence on the climates of the earth.

MAXIMA AND MINIMA OF TEMPERATURE.

A certain degree of heat is necessary to give mobility to the sap of plants, and this differs in each species of plant. Vegetation is accelerated and becomes luxuriant, provided it is furnished with a corresponding amount of humidity to compensate for the evaporation as we increase the quantity of heat. It is, therefore, important to determine the average amount of heat in different places; but for this certain precautions are indispensable. It is not the direct heat of the sun that we, at first, wish to ascertain, but that of the air. It is necessary, therefore, to suspend the thermometer to a badly-con-

ducting body, and the instrument itself should not have so great a volume as would prevent its readily taking the temperature of the atmosphere. If the bulb is large and the stem small, the degrees may readily be divided into small fractions; but in this case the thermometer will fall behind in its indications, since, if the temperature be increasing, some time must elapse before the instrument can arrive at this new condition; and in case it be falling, a similar tardiness will be exhibited. If, on the other hand, the bulb be very small, the degrees will be of less length; and since there is little of the fluid to be heated or cooled, it will more readily take the temperature of the circumambient air. For determining, however, the mean temperature of a place, the thermometer should not be too small, since, in that case, it will be more easily affected by the heat of the body during observation, and at the same time it may be affected by an accidental or fitful stream of air, and thus give too high or too low an indication. One of the ordinary size, in which the bulb is about half an inch in diameter, is preferable.

For a similar reason, the thermometer ought not to be suspended in immediate contact with a large solid conducting body, for example, a stone or brick house, since this will retain the effects of a term of heat perhaps for several hours after the temperature of the air has changed. It should be suspended from an imperfectly conducting material, such as wood, and so situated that the air may circulate around it on every side. It should also be screened from the direct radiation of the sun, and from the reflection of surrounding bodies; for, if this be not done, it will indicate the average of all the impressions received, and not simply the temperature of the air. The thermometer, therefore, ought to be placed in the shade on the north side of the house, but a few feet above the level of the ground, in an unobstructed place; and, indeed, it has been recommended to suspend it between two large parallel horizontal disks of wood, which will protect it from the earth below, the sky above, and every influence, except that of the stratum of air in which it is situated. Instead of this, however, we may enclose it in lattice-work, easily permeated by currents of air, and painted white on the outside to reflect off the more intense rays of heat which may accidentally reach it.

If our instruments consist of a maximum and a minimum self-registering thermometers, exposed to the air in the way we have indicated, it will be sufficient, in order to obtain the average temperature of the day approximately, to note the temperature but once in twenty-four hours. If we then add together the maximum and minimum, and divide the sum by two, we shall have approximately the average temperature; but this is not precisely the quantity required for meteorological and agricultural purposes, or that which enables us to judge of the heat of different days or different periods, since the thermometer may, at different times of the day, be suddenly elevated or depressed, and not reach its maximum and minimum gradually, as is usually the case.

To determine these with more precision, and the average temperature of the air during the day, we must observe the thermometer at

very short intervals; for example, every quarter of an hour. If we add these into one sum, and divide by ninety-six, we shall have the mean or average temperature of the day. Before division, however, caution is to be observed in combining the observations taken in winter, or, when the temperature sinks below zero, to subtract the sum of the observations with the *minus* signs from the sum of those with *plus* signs.

In running our eye down the column of a series of observations of this kind, we can mark not only the maximum and minimum temperature for the day, but also the time at which they occurred. If we continue these observations, during a month of thirty days for example, we shall obtain thirty maxima, and as many minima, and an equal number of mean temperatures. If we now add these thirty observations of the same kind together, and divide by the number thirty, we shall obtain the maximum, the minimum, and the mean of the month. Similar observations, continued throughout the year, and thus combined, will give us the mean of all the maxima, of all the minima, as well as the general mean of all the three hundred and sixty-five or three hundred and sixty-six days of which the year may be composed.

There is still another way of combining these observations. We may take, for example, the mean of all the temperatures of mid-day for the month or the year, or of any other hour of the twenty-four, and from this, obtain the mean temperature of all hours of the day and night. Finally, instead of limiting our observations to a single year, we may extend them to a series of years, in order to determine more accurately the mean temperature of a given place, all accidental variations of particular years and seasons being reasonably supposed to balance each other. It is by this admirable invention that order and regularity are deduced from phenomena which appear under the influence of no fixed laws, and that we are enabled to arrive at permanent and constant quantities by eliminating those which are irregular and variable.

A series of observations continued during the day and night through a number of years, or even a single year, involves an amount of labor which few men of science can afford to bestow upon meteorology, or who have the industry and perseverance necessary to so prolonged and tedious an effort. This task, however, has been performed under the direction of several persons in this country, namely, Prof. Dewey, in Massachusetts; Capt. Mordecai, at the United States Arsenal, near Philadelphia; Prof. Bache, at Girard College; Prof. Snell, at Amherst; and Col. Le Froy, of Toronto, not to mention the names of a large number of persons who have executed the same work in Europe. Could it be repeated in a number of different places in this country, the results would be of essential importance in correcting the ordinary observations made at fixed hours of the day.

To illustrate these observations and the uses to which they may be applied, we will select a series made since 1816, at the Observatory of Paris, by M. Bouvard, at six different epochs of the day, namely,

from nine o'clock till mid-day, and from three to nine in the evening, the other hours being given by interpolation:

Hours.	Temperature. Centigrade.	Temperature. Fahrenheit.
	°	°
Midnight.	8.5	47.30
1	8.1	46.58
2	7.7	45.86
3	7.4	45.32
4	7.13 min.	44.83
5	7.5	45.50
6	8.2	46.76
7	9.2	48.56
8	10.3	50.54
8⅓	10.67 mean	51.21
9	11.21	52.18
10	12.1	53.78
11	12.9	55.22
Noon.	13.5	56.30
1	14.1	57.38
2	14.47 max.	58.05
3	13.91	57.04
4	13.4	56.12
5	12.8	55.04
6	12.2	53.96
7	11.6	52.88
8	10.8	51.44
8⅓	10.67 mean.	51.21
9	10.19	50.34
10	9.7	49.46
11	9.1	48.38
Mean	10.67	51.21

From this table we see, first, that the annual mean temperature at Paris is 10.67 centigrade, or 51°.21 F. Second, that the minimum is near four o'clock a. m., and the maximum about two o'clock p. m. Thirdly, which follows from the last, the air is heated during ten consecutive hours, and is cooled during fourteen hours. Fourth, that we fall into a small error in deducing the mean temperature from the maximum and minimum of the day, the true mean being 10°.67; the other is 10°.8. Fifth, that the mean temperature is at 8 h. 20 min. in the morning and 8 h. 20 min. in the evening. From this it is evident that, in order to find the mean temperature of the year, it is sufficient to observe the thermometer each day at twenty minutes past eight in the morning and at twenty minutes past eight in the evening; but if our object is to obtain the mean for each month of the year, it is necessary to change the hour in question, since it is found that for January 1 o'clock is the proper hour; for July, 7 o'clock; and for all the other months, the hours intermediate. The epoch of the mean of the evening experiences similar changes.

Having discussed the variations of the temperature of different hours, it now remains to speak of the monthly variations. From twenty years' observations at Providence, Rhode Island, the following result has been obtained by Professor Caswell, of Brown University. This gentleman has made a series of observations extending through upwards of a quarter of a century, and has presented the whole to the Smithsonian Institution for publication.

Temperature of Providence, Rhode Island; by Prof. A. Caswell.

YEARS.	MONTHS.												Year.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	
838	32.5	17.9	35.1	40.8	53.5	68.2	75.0	71.0	61.4	47.2	35.3	25.8	47.0
1839	26.3	27.9	34.9	46.7	56.0	62.2	71.7	67.9	61.1	51.5	37.3	30.6	47.8
1840	18.6	32.9	36.0	47.5	57.3	67.6	72.2	70.9	58.5	51.3	39.2	27.7	48.3
1841	30.5	25.1	35.1	42.2	54.1	68.6	70.0	69.2	63.2	45.8	37.3	32.7	47.8
1842	30.8	34.4	39.7	46.3	53.4	64.2	71.8	68.3	59.3	50.9	38.7	30.2	49.0
1843	34.2	22.4	28.7	45.3	54.4	64.3	68.8	69.8	61.3	49.3	37.6	30.9	47.2
1844	20.2	28.2	36.3	50.6	58.5	64.6	68.4	67.8	59.6	49.9	39.1	32.2	47.9
1845	30.7	28.5	41.3	44.6	54.2	64.8	69.0	68.2	57.5	50.7	42.5	24.9	48.1
1846	27.3	21.7	39.4	46.3	53.2	60.7	67.5	71.2	66.0	50.2	44.6	29.8	48.2
1847	29.3	28.7	32.3	43.0	54.3	65.6	71.3	68.7	62.3	49.8	45.8	39.6	49.2
Mean of 10 years	28.0	26.8	35.9	45.3	54.9	65.1	70.6	69.3	61.0	49.7	39.7	30.4	48.1
1848	32.3	27.4	33.3	46.8	58.8	66.2	70.2	79.4	59.7	51.3	37.8	37.3	50.0
1849	24.6	22.3	37.0	43.7	54.2	67.5	70.6	69.9	60.5	50.9	47.3	31.2	48.3
1850	30.5	32.2	34.0	43.1	52.3	67.2	72.4	67.8	60.7	52.9	43.5	29.3	48.8
1851	29.8	32.1	38.5	46.3	56.4	64.2	70.6	67.7	61.0	53.7	36.9	25.5	48.5
1852	23.9	28.6	34.7	41.8	57.1	67.7	72.4	66.6	62.6	52.4	39.7	37.8	48.8
1853	28.4	30 5	36.0	44.4	57.0	66.9	70.8	69.2	62.5	49.4	42.6	28.6	48.9
1854	26.4	25.6	33.1	42.9	57.7	65.9	72.9	68.6	61.4	52.9	40.7	26.5	47.9
1855	30.0	21.1	32.6	44.1	54.7	65.3	72.9	67.9	61.9	52.4	42.0	32.3	48.1
1856	19.3	22.7	27.8	46.8	53.5	67.7	72.1	69.8	63.2	50.2	39.4	25.5	46.5
1857	16.3	32.7	32.2	41.0	52.8	62.0	69.9	66.8	60.3	50.5	42.3	34.6	46.8
Mean of 10 years	26.1	27.5	33.9	44.1	55.4	66.1	71.5	69.4	61.4	51.7	41.2	30.9	48.3
Mean of 20 years	27.1	27.1	34.9	44.7	55.2	65.6	71.0	69.3	61.2	50.7	40.5	30.6	48.2

It appears from this table that the coldest month is January, and the warmest are July and August, which are nearly the same. The mean temperatures of April and October are nearest to the mean of the year. In the two periods of ten years each, at Providence, the difference between the mean temperatures is but two-tenths of a degree; the differences, also, between the mean temperatures of the several months in the two decades scarcely differ a degree in the whole series. If the times were further extended, the agreements

would probably be closer, the instruments remaining the same. These facts illustrate the truth of what we have previously said relative to the deduction of definite results from the most complex and variable elements, and the permanency of the mean temperature of a given position; the sum of the variations consisting in oscillations on either side of the mean, which, in the aggregate, neutralize each other.

It is known, from extended observation, that the same weather exists at the same time over a large extent of country. For example, during a cold winter, it is comparatively cold over the whole of France, and in the State of New York, though the temperature be different in different places, a cold January will be cold over the whole State; hence a table carefully made at any one place will serve to indicate the relative temperature of others in the same district.

We see from the foregoing table that the greatest heat of the day, at Paris, happens at 2 o'clock, while we know that the solar rays are most intense at 12 o'clock. We have, in a previous report, given an explanation of this phenomenon, namely, that the earth is constantly radiating heat into space and receiving it from the sun the whole time it is above the horizon; the temperature, therefore, will constantly increase while the amount of heat received is greater than that given off. The greatest amount of heat received in a minute is at 12 o'clock, and hence the increase of temperature at this time will be the greatest; but the earth, after 12 o'clock, still continues to receive more heat than it gives off, and hence the temperature of the air will still continue to increase, though at a less rapid rate, until about 3 o'clock, in our latitude. The radiation into space from the earth and the absorption from the sun about balance each other, and the temperature will then remain stationary at its maximum point during some time, the loss and gain being equal. After this, the loss is greater than the gain, and this goes on continually until the setting of the sun, when the radiation is entirely uncompensated, and cooling takes place, at first with a sudden accelerated velocity, and then gradually diminishes in intensity until daylight, when the earth has arrived at the minimum of temperature. After this, again, the earth begins to receive more heat than it loses, and the temperature of the air constantly rises again until 2 o'clock. If the earth were to radiate heat as rapidly at night as it does in the day, the minimum temperature would be at about 9 o'clock in the morning; but on account of the diminished radiation with diminished temperature, the compensation takes place about the rising of the sun. When the radiation towards the sky is prevented by a transparent covering which admits the radiation from the sun, as in the case of a house lighted by windows in the roof, the maximum temperature takes place at a much later period of the day; and, indeed, were the radiation to the sky entirely stopped, the temperature of the earth would increase indefinitely.

Temperatures below the surface.—At a certain depth below the surface of the earth there is a stratum of invariable temperature, the depth of which augments with the latitude, and in our climate is from about 100 to 115 feet. In general, the temperature of this

stratum appears to be a little more elevated than the mean annual temperature of the surface, and this excess appears to increase with the latitude. This stratum, it is evident, cannot be a regular surface, since it must necessarily partake in a considerable degree of the varying contour of the external surface of the earth. The first observations which were made upon this subject were in the cellars of the Observatory at Paris, at the depth of 67½ feet below the surface. They extend over a period of more than fifty years, and show an invariable temperature of 53°.28 F. The thermometer used in these observations was a most delicate one, constructed by Lavoisier, and it, in no instance, showed a variation of one-tenth of a degree Fahrenheit above or below 53°.28; and even these variations, small as they are, have been traced to accidental causes.

Below the surface of the ground, and at a depth of from 65 to 80 feet, but few observations have been made, and these have been principally applicable to the middle latitudes of the northern hemisphere. From all the observations Pouillet gives the following deductions:

1. The *diurnal* variations are not perceptible at depths greater than about 40 inches.

2. The mean *annual* temperature of the different strata differs little from the mean annual temperature of the air.

3. The differences between the maxima and minima of the different strata decrease in a geometrical progression, while the depths increase in an arithmetical progression.

4. From all the observations it appears that, at a depth of from 26 to 29 feet, the annual variation is only 1°.8 F.; at from 49 to 52 feet, it is but 0°.18 F.; and at a depth of from 65 to 81 feet, it becomes only 0°.2 F.

5. At the depth of about 26 feet, or where the variation is 2° F., the seasons are precisely reversed; that is, the maximum temperature occurs about the 1st of January, and the minimum about the end of June.

Effect of heat on plants.—We have stated that all the transformations of matter going on around us, the power exhibited in the growth of the plants, in the functions and motions of animals as well as in the winds, are all referable to impulses received from the sun; but the mere continuance of the heat of a body at a certain temperature does not produce a continuous change in it; for example, a piece of metal, when kept at the same temperature, may remain unchanged for years; provided the intensity of the heat is not sufficient to melt it. In order, therefore, that heat may do work, or effect a permanent change in matter, it is necessary that it be applied by means of some mechanical arrangement analogous to a machine. In most cases, an intermediate agent, such as steam or heated air, is employed in connexion with the machinery, and we have a striking natural arrangement of this kind in the organization of the plant. If the stem of a plant were solid, and did not consist of minute cells filled with evaporable liquid, the heat of the atmosphere, so long as it were constant, would produce no change. To understand this, let us suppose a tube of glass, with a minute bore—for instance, the tube of a

broken thermometer—to have its lower end placed in water, the liquid will rise perhaps to an inch above the general level of the liquid in the vessel, and here it will remain. The cause of this ascent is the attraction of the glass for the liquid and the liquid for itself, and is familiarly known under the name of capillarity. A perpetual flow of water can never be produced by this action, since, if we cut off the tube before mentioned, leaving but three-fourths of an inch above the water, the attraction of the glass will draw the liquid up to the very top, but will not permit it to run over, because the same attraction which suspends it will prevent it from overflowing. The atom of water at the top of the tube will be attracted as much downward by the glass as the next one below will be attracted upwards; hence an equilibrium will ensue.

If, however, we apply heat to the upper surface, which will evaporate the water, a new portion will be drawn up to restore the equilibrium; and if this process be continued, a constant current will be maintained, and a definite amount of mechanical work will be performed. If the liquid contain different substances in solution, these will be retained, it may be, in the solid form, and in this way a solid substance may be brought up and deposited at the end of the tube. If across the lower end of the tube a porous membrane be stretched, and if the liquids above this, and that in the vessel below, be of a different quality, which would necessarily result on account of the evaporation mentioned, then the ascentional power would be very much increased by the process called endosmose. Without considering at present this action very minutely, we may apply the principles we have here given to the means by which heat becomes a motive power in building up the plant. The stem of a tree is an arrangement analogous to an assemblage of minute tubes, such as we have described, terminating in leaves above, from the surface of which constant evaporation is going on, and a current of liquid ascending called crude sap, which consists of water containing in solution the various substances imbibed by the roots, and elaborated by the leaves. The tubes are not continuous, but are elongated cells analogous to a glass tube, the ends of which are closed with porous membrane.

We can scarcely doubt that by this arrangement, the motive power which gives rise to the circulation of the sap is the heat derived from the atmosphere and the direct rays of the sun. But a small part, however, of the material of which the plant is built up, namely, carbon, is elevated from the roots. This is furnished, as we have before stated, by the decomposition of the carbonic acid absorbed from the atmospheres into the pores of the leaves, and there decomposed by the chemical ray of the sun. It is at this place that the liquid brought up by evaporation is elaborated into true sap, under the principle of vitality, and this is carried downward through the cells by endosmose, and serves by secretion to build up new cells, and thus to increase every part of the plant. The rapidity of evaporation will depend, the amount of heat being the same, upon the quantity of vapor already in the atmosphere; and hence, with the same degree of temperature, the amount of work performed would appear to be

greater in a dry than in a moist atmosphere; but since the carbonic acid, which is decomposed, is probably absorbed by the water in the leaf, too rapid an evaporation will retard rather than increase the useful effect.

But little is known of the minutia of this process, and how far other causes than those that are now known to exist influence the results cannot at present be stated. We are assured, however, by observation, that beyond a certain degree of heat, a given plant cannot have a healthy condition, and also below a certain temperature, which is still above freezing, the sap of plants ceases to have an active, if any, circulation.

Heat necessary for the growth of plants.—The hypothesis was early advanced, that for each plant a certain amount of heat is requisite in order to its development from one stage of growth to another; for example, in the case of *wheat*, from the time it begins to sprout until it arrives at its full maturity, a definite quantity of heat is required, other conditions being the same, though the time in which it may be furnished may be different in different instances. Different methods, however, have been proposed for estimating this heat. Reaumur, who first advanced the hypothesis of the definite amount of heat, as well as late writers on the subject, has proposed to calculate it by multiplying the number of days the plant is in passing through its growth by the mean temperature of each day; while M. Quetelet, of Brussels, who has made more experiments on this subject than any other person, thinks that the heat ought to be measured, not by the simple product of the sum of the temperatures of the several days, but by the sum of the squares of the temperatures of these days. He deduces this rule from the consideration that if heat be due to vibration, the impulses from it ought to do work in proportion to the square of the intensity, and not simply in proportion to the intensity. For example, a cannon ball moving with twice the velocity, will penetrate a wall four times as far—moving with three times, nine times as far, and so on, in proportion to the square of the velocity. In accordance with this, let S represent the amount of heat required to produce the full development of the plant, and t and t^1 be the mean temperatures of the several days; then will $S=(t)^2+(t')^2+(t'')^2$, &c. It follows, as a consequence of the law of the square of temperatures, that alternation of temperatures within certain limits may produce greater effect than a uniform temperature. For example, if on three consecutive days, the temperatures were 70°, 60°, and 80°, and on three other days, 70°, 70°, 70°, though the average heat is the same, the effect of the former will be slightly greater than that of the latter; since the sum of the squares of the first is 14,900 while that of the latter is 14,700.

From *a priori* considerations there can be no doubt that, to produce a given amount of organization, a definite amount of power must be expended; but we are unable to say in the present state of science how much of the power which may disappear is lost in producing other than useful effects. Also, in the foregoing investigation, it might reasonably be supposed that the mean heat of the day, in part,

should be derived from the heat of the sun, and not alone from that of the air. The upper surface of a plant will be heated by the direct rays of the sun, while the lower will be exposed, in the shade, to the heat of the air. It has, therefore, been proposed to employ the temperature obtained from the mean of the observed thermometer in the sun and in the shade during the day. To render this principle of use in practice, a series of observations on the temperatures in different seasons of the year, of thermometers in the sun and in the shade, would be necessary. Besides this, since vegetation is comparatively but little advanced at night, the length of the day should be taken into account, which in the neighborhood of the equator is 12 hours, and in the vicinity of the polar circle nearly 24 hours. Another correction is necessary in order to reliable comparative results, namely, that which is due to the fact that different plants begin to show signs of vitality in the spring at different temperatures.

Allowing the truth of the proposition, of the definite amount of heat required for the full development of each plant, we have a ready explanation of the fact that some grain will come to maturity in climates of very different temperatures, the less intensity of heat being compensated for by the longer duration of the day. Though each species of plant may require a definite amount of heat for its perfect maturity, yet this is by no means the measure of the power expended in the organization, though it may bear a definite ratio to it. The chemical ray of the sun decomposes carbonic acid, and thus furnishes the greater part of the material of which the plant is composed, and, in the process of germination and assimilation, probably furnishes a portion of the power necessary to carry on these processes.

The following table is selected from the memoirs of M. Quetelet, of Belgium, and contains the times of leafing, blossoming, and fructification of plants found in this country, as well as in Europe. The selection has been made at my request by Dr. L. D. Gale, of Washington, and it is hoped that the times will be compared with those pertaining to the same periods of the developments of the same plants in different parts of this country.

The observations from which the original table was constructed were made in the garden of the Royal Observatory, at Brussels, and, according to the author, they may be applied not only to Belgium, but also to the whole of Europe, due regard being had to the differences of latitude and elevation between Brussels and other places. The correction for each degree of latitude is four days for each degree, to be added or subtracted according as the place is to the south or north of Brussels. The correction for elevation is a retardation, also, of four days for every 330 feet above Brussels, which is itself about 195 feet above the level of the sea. It must be understood that these corrections are only approximate, for we are obliged to abstract the consideration of the nature of the soil, the exposure of the plant, and the more or less continental locality, that is, the greater or less distance from the sea.

Plants that grow in Europe and in the United States, whether indigenous or introduced—experiment continued ten years.

BY M. QUETELET, OF BRUSSELS.

The time of leafing—latitude of Brussels.

NAMES OF PLANTS.	Mean time.	Earliest.	Latest.
Acer pseudo-platanus, false sycamore, a maple	April 20	April 7	April 28.
Æsculus hippocastanum, horse chestnut	April 6	March 27	April 27.
Amygdalus persica, peach	March 28	March 4	April 19.
Berberis vulgaris, barberry	March 22	Feb. 26	April 14.
Betula alba, white birch	April 9	March 27	April 20.
Bignonia catalpa, catalpa tree	May 1	April 17	May 19.
Cratægus oxyacantha, English hawthorn	March 23	Feb. 25	April 16.
Clematis viticella, Italian clematis	March 25	Feb. 23	April 20.
Daphne mezereum	March 13	Feb. 23	April 4.
Fraxinus nigra, black ash	April 26	April 15	May 5.
Juglans nigra, black walnut	April 28	April 19	May 10.
Lonicera Tartarica, Tartarian honeysuckle	March 6	Jan. 30	April 5.
Morus alba, white mulberry	May 2	April 21	May 15.
Philadelphus coronarius, mock orange	March 18	Feb. 23	April 13.
Populus balsamifera, balm of Gilead	April 5	March 14	April 22.
Prunus cerasus, cherry laurel	April 6	March 27	April 21.
Prunus domestica, common plum	April 2	March 6	April 23.
Prunus spinosa, sloe, black thorn	April 1	March 1	April 23.
Pyrus communis, common pear	March 30	March 10	April 22.
Pyrus malus, apple	March 30	March 12	April 20.
Rhus typhina, staghorn, sumach	April 19	April 1	May 7.
Ribes grossularia, gooseberry	March 8	Feb. 18	April 3.
Ribes rubrum, red currant	March 17	Feb. 25	April 8.
Ribes nigrum, black currant	March 17	Feb. 24	April 8.
Robinia pseudo-acacia, white locust	April 23	April 9	May 10.
Sorbus aucuparia, mountain ash	April 7	March 18	April 21.
Tilia Europæa, European linden tree	April 7	March 18	April 22.
Populus alba, white poplar	April 12	April 1	May 1.
Magnolia grandiflora, great flowered magnolia	April 19	April 4	April 29.
Gleditschia ferox, honey-locust tree	May 9	April 30	May 26.

Time of flowering.

NAMES OF PLANTS.	Mean time.	Earliest.	Latest.
Acer pseudo-platanus, false sycamore, a maple	April 28	April 19	May 10.
Achillæa millefolium, yarrow	July 13	July 5	July 30.
Aconitum napellus, monkshood	June 1	May 15	June 12.
Æsculus hippocastanum, horse chestnut	May 3	April 23	May 16.
Amygdalus Persica, peach	March 20	Feb. 27	April 8.
Berberis vulgaris, barberry	May 4	April 18	May 20.
Betula alba, white birch	April 8	March 22	April 22.
Cratægus oxyacantha, English hawthorn	May 4	April 16	May 23.
Clematis viticella, Italian clematis	June 29	June 2	July 14.
Daphne mezereum	March 15	March 3	April 2.
Lonicera Tartarica, Tartarian honeysuckle	May 9	April 23	May 23.
Morus alba, white mulberry	May 22	May 15	June 3.
Philadelphus coronarius, mock orange	May 23	May 11	June 4.
Populus balsamifera, balm of Gilead	March 23	Feb. 28	April 20.
Prunus cerasus, cherry laurel	April 16	April 2	May 4.
Prunus domestica, common plum	April 16	March 27	May 3.
Prunus spinosa, sloe, black thorn	April 7	March 2	April 30.
Pyrus communis, pear tree	April 13	March 9	May 2.

Plants that grow in Europe and the United States—Continued.

NAMES OF PLANTS.	Mean time.	Earliest.	Latest.
Pyrus malus, apple	April 25	April 12	May 8.
Rhus typhina, sumach	July 13	July 5	July 25.
Ribes grossularia, gooseberry	May 3	March 12	April 22.
Ribes rubrum, red currant	April 2	March 18	April 22.
Ribes nigrum, black currant	April 14	March 28	April 30.
Robinia pseudo-acacia, white locust	May 30	May 17	June 12.
Sorbus aucuparia, mountain ash	May 2	April 16	May 15.
Tilia Europæa, linden tree	June 9	May 15	June 17.
Populus alba, white poplar	March 23	Feb. 28	April 20.
Magnolia grandiflora, great flowered magnolia	April 16	March 8	April 25.
Amorpha fruticosa, common false indigo	June 12	May 28	June 24.
Anthemis cotula, mayweed	June 5	May 6	June 19.
Time of fruit.			
Acer pseudo-platanus, false sycamore, a maple	April 30	Oct. 25	Nov. 3.
Amygdalus Persica, peach	Aug. 22	Aug. 5	Sept. 11.
Prunus cerasus, cherry laurel	June 11	May 30	June 24.
Pyrus communis, common pear	Aug. 26	July 28	Sept. 14.
Ribes grossularia, gooseberry	June 25	June 16	July 8.
Ribes rubrum, red currant	June 15	June 6	June 29.
Ribes nigrum, black currant	June 15	June 8	June 27.

Heat on different surfaces.—The amount of heat which falls upon a given surface depends upon the inclination to the different points of the horizon. A field, for instance, in our latitude sloping towards the south, receives a greater, and one towards the north a less amount of heat; moreover, the former obtains more than an equal extent of ground parallel to the horizon, and the latter, as in the other case, much less. A field, also, which slopes in an easterly direction receives less heat than another inclined towards the west, inasmuch as more reaches the latter, since the maximum heat of the day takes place after the sun has passed the meridian; as it is, each of these enclosures gets a less amount than one of equal extent parallel to the horizon.

Estimate of temperature by rings in trees.—It frequently happens that permanent records are found of the past condition of our globe in the impressions retained in the rocky strata, and that the yearly occurrences of certain phenomena, such as the annual deposit from the overflowing of banks of rivers. Such records may be rendered available in determining the time of actions which may have long since ceased, or which continue to the present day. It is well known that the trees of our latitude increase in size by the deposition of an additional layer annually between the wood and the bark, and that a transverse section of such a tree presents a series of concentric, though irregular rings, the number of which indicates the age of the tree. The relative thickness of these rings depends on the more or less flourishing state of the plant in the year in which they were formed, and therefore indicates the relative state of heat and moisture during the same period. Furthermore, each ring in some trees may

be observed to be subdivided into others during the same year, indicating that the vegetation was advanced or checked at intervals during the season. Furthermore, it has been found by observation that even the motion imparted to a tree by the wind has an influence on its growth, giving an oval form to its trunk, the longer direction of which will be that of the prevailing wind. A thin slice, therefore, cut from a large tree at right angles to its axis, carefully polished and varnished, forms a natural record of the weather well calculated to call forth admiration and to impart instruction. It is scarcely necessary to remark that the year should be carefully identified, corresponding to a given circle, in order that the whole might be properly numbered.

Mr. Babbage has proposed an ingenious application of this principle for carrying back the series of records by means of trees which are found in the deep bogs of different parts of Great Britain. By searching for corresponding thick or thin rings in the outer circumference of one tree and in the inner of another, a number of trees may be arranged in a series, and thus the record extended back into the geological periods. Whatever may be the practical value of this plan, it is certainly ingenious and worthy of attention. Since the trees found in bogs are, we may suppose, the regular and consecutive productions of the primitive forests, they would probably represent the successive vegetation of a series of centuries.

The remains of plants found in the rocky strata indicate that the same diversity of weather and the same changes of seasons existed in the past geological ages as at the present time. By carefully studying the rain marks on sandstone, the direction of the wind, during storms in the ancient periods, may be determined; and this will probably be found the same as in thunder showers of the present day. The remains of plants and animals of a tropical character, found abundantly in the northern regions, assure us that the temperature of the surface of the whole globe has undergone remarkable changes.

Effect of different surfaces.—The rays of heat from the sun which strike the earth are partly reflected into space and partly absorbed by the surface in producing an elevation of temperature. The absorbent and reflective powers are complementary to each other, and vary very much in different substances, and, as we have seen, according to their color and texture. Lampblack possesses this power of absorption in the greatest degree; and if we represent this by 100, that of common glass will be 90, and that of polished metallic surfaces about 6. Consequently, the latter have a high reflective power, while that of lampblack and other dark substances is very weak. This is a matter of interest to the agriculturist, since the amount of heat which may be received by a given suface will depend very much upon its color; and, indeed, in some cases, charcoal or other dark substance has been strewed over the ground to increase its absorptive power.

The following table by M. Schubler is copied from Becquerel, and gives the greatest elevation of temperature obtained by different soils exposed to the direct rays of the sun, while the surrounding air was at about 78°.

Maximum temperatures of various earths exposed to the sun, by Schübler.

KIND OF EARTH.	Maximum temperature of the superior layer, the mean temperature of the ambient air 77° F.	
	Moist earth.	Dry earth.
	°	°
Silicious sand, yellowish gray	99. 05	112. 55
Calcareous sand, whitish gray	99. 10	112. 10
Argillaceous earth, yellowish gray	99. 28	112. 32
Calcareous earth, white	96. 13	109. 40
Mould, blackish gray	103. 55	117. 27
Garden earth, blackish gray	99. 50	113. 45

The differences of temperature exhibited by the two columns are due to the heat expended in the evaporation of a portion of the water in the moist earth, while the differences between the different substances are principally to be ascribed to the colors, though the texture may have some effect.

Absorptive power is connected with that of emission; and those bodies which possess the greatest absorptive power for heat of a low intensity, also possess the greatest emissive power for heat of the same kind. But the preceding remarks have reference to the rays from the sun and not to those of dark heat; and here I must stop to recall the fact which is frequently neglected, even by scientific men, namely, that color has no effect upon the absorption or emission of rays of low intensity. For example, if we pass our hands over a sign-board, on which dark letters upon a white ground are exposed to the sun, we can readily perceive, with our eyes shut, the difference of temperature; but this would not be the case were the board exposed in the dark to the heat of a stove of a temperature below redness. Furthermore, if the same board were exposed to the clear sky and suffered to cool by its own radiation, no difference of temperature would be observed in the different parts of its surface, except a very slight one, which might be due to the difference of the radiating power possessed by the substances of which the black and white paints are composed. On this subject, Prof. Bache, the Superintendent of the Coast Survey, has made a series of very interesting experiments. He found that canisters of tinned iron filled with water and painted externally of different colors required the same time to cool through a given number of degrees. The facts in regard to this point may be generalized by saying that color has no influence whatever upon the emissive power of different bodies, but that its influence is confined to the reception of rays of high intensity, or those which approximate in quality to the luminiferous emanations. Hence a black or a white dress is equally cool in the night, though in the sunshine the darker one would absorb the greater amount of heat.

Besides color, as we have stated. the humidity of the soil has great influence upon the temperature it acquires, a portion of the heat being expended in evaporating the water. We have seen the statement somewhere that the average temperature of whole districts in Great Britain has been elevated one degree by the system of drainage adopted in that country.

In addition to the preceding causes, there are two others which affect the temperature of the soil, namely, conduction and capacity for heat. In a porous, badly conducting substance the heat which may escape from the surface is not readily supplied from the interior, and hence such bodies are long in cooling. Again, different bodies contain very different amounts of heat at the same temperature, and hence one body may take a much longer time to cool down to the same temperature through the same number of degrees than another. That two different bodies of the same weight at the same temperature possess different amounts of heat, may be shown by first heating, say a pound of each in boiling water, and afterwards plunging them separately into equal amounts of cold water of, say 32°. It will be found that the heat which they severally impart to the water in the two cases will be very different.

The following table, also from Becquerel, gives the relative retention of heat by different soils, that of calcareous sand being one hundred, and also the time of cooling of cubes of the same size of the different earths:

Table of retention of heat, by Becquerel.

KIND OF EARTH.	Capacity for heat, that of calcareous sand being 100.	Time required by 18 feet cube of earth to cool from 144°.5 to 70°.2, the temperature of the surrounding air being 61°.2.
		h.
Calcareous sand	100.0	3.30
Silicious sand	95.6	3.27
Argillaceous earth	68.4	2.24
Calcareous earth	61.8	2.10
Mould	49.0	1.43

EFFECT OF COLD.

While the periodic temperature of a given place depends upon the position of the sun in its course, the abnormal hot and cold periods, or terms, as they have sometimes been called, are due principally to winds from certain directions. The cold terms in this country generally begin in the northwest, and advance southerly and easterly, and are accompanied with winds from the north and northwest. We

do not, however, intend in this place to discuss these abnormal variations of temperature, but to consider the effect of cold on different bodies, including plants and animals. We shall first consider its effects on a surface of water.

Effect of cold on water.—When the surface of water is exposed to a low temperature, the upper stratum is cooled, it becomes specifically heavier, and sinks. A lower portion then comes to the surface, which, in its turn, is cooled, becomes heavier, and again gives place to another stratum, to pass through the same process. This continues till the column of water originally included between the surface and the bottom is reduced to a temperature of about 39° F., at which point the fluid ceases to shrink, or, in other words, to become heavier, but, on the contrary, expands with every diminution of heat, until it becomes entirely solidified. After it has assumed the solid condition, it follows the law observed by other solids, and shrinks with every subsequent fall of temperature. After the water of a given reservoir has arrived at a temperature of 39°, since it does not increase in weight, it continues to float on the surface, and is rapidly cooled down to 32°, or the point of congelation. Before, however, it can be converted into a solid at this temperature, it is necessary to abstract from it a large amount of latent heat.

To render this plain, let us suppose a lump of ice, taken at zero, and placed, with the bulb of a thermometer in it, under such conditions that it shall receive from surrounding bodies one degree of heat in one minute of time. We shall find in thirty-two minutes the thermometer will come up to the freezing point; but here we shall observe that the mercury ceases to rise, although the supply of heat remains the same, and it will continue stationary during one hundred and forty minutes, or until all the ice is melted, after which, it will again begin to rise, and continue its upward march until the water begins to boil, when a second stationary point will be reached. The heat, which continued to flow into the ice during the stationary period, appears necesssary to convert it from a solid to a liquid state, and, inasmuch as it does not affect the thermometer, it has been called latent or concealed heat. Water, therefore, at 32° contains 140° of heat more than ice at the same temperature. In the freezing of water, a reverse process takes place, and 140° of heat have to be abstracted before the liquid is converted into a solid. Freezing, therefore, independent of the previous cooling down of the mass in the reservoir to 39° and the upper film to 32°, is comparatively a slow process. For example, if we expose a stratum of water at a temperature of 20° above freezing to the air below 32°, and it requires twenty minutes to reduce it to the point of congelation, one hundred and forty minutes will be required to solidify it, or seven times as long. In melting the ice, the same amount of heat has to be absorbed, so that a large extent of deep water becomes a regulator of temperature, preserving the air immediately over it at near 32°, though the atmosphere in the vicinity during the winter may be far below zero; conversely in the spring, though the temperature of the

same latitude may be 60° or even 80°, that of the air immediately over the water will be near 32°. It is evident, from these facts, that the deeper the reservoir the longer will the continuance of low temperature be required to freeze the surface, and the longer the time necessary for melting it again. These principles are illustrated in our great lakes. The greatest known depth of Lake Superior is 792 feet, and soundings of 300, 400, and even 600 feet are not uncommon. In the coldest weather, the water over these deeper places is above 32°, and does not freeze, while over the shallow parts a coating of ice is formed, which, gradually cooled by the slow diffusion of the water underneath, retains its solidity until the last of June. Indeed, ice is sometimes found at the surface in the middle of July. At this period of the year, or a little later, the smaller ponds of water in the vicinity have a temperature of 72° to 74°. Lake Erie, being much shallower, sometimes freezes entirely across, and becomes in summer heated throughout its extent to nearly the temperature of the supernatent air. At the beginning of September, 1857, the temperature of Lake Huron was 56°, while that of the water from Lake Erie, which passed over the Falls of Niagara, was 72°, precisely that of the air.

All bodies, as we have previously said, in passing from a liquid to a solid state, tend to assume a regular geometrical arrangement called crystals. This is particularly observable when the process has been slow, and undisturbed by agitations or tremors. The form peculiar to each substance is exhibited when a portion, only, of liquid has assumed the solid state, as in the case of the shooting of spicules across the surface of water, in a metallic basin, exposed to the cold.

It will be found, on inspection, that the filaments of ice arrange themselves at definite angles of either 60° or 120°, and that the triangular openings are bounded by sides making the same angles with each other. In reference to crystallization, there is an important law to be borne in mind, namely, that the axis of the crystal always tends to be at right angles to the surface of the cooling mass. For example, if a quantity of melted zinc be poured into a cylindrical hole in cold sand, and the bar thus formed be broken across, the crystals will be found to be arranged in the form of radii, with their bases in the circumference; and in some cases, there will be found a cylindrical hole along the axis, from which the metal has been drawn away by the shrinking at the time of cooling and crystallization. A precisely analogous arrangement takes place in the freezing of water, which may be observed by placing a quantity of this liquid in a globular glass vessel, and submitting it to a temperature of some 10° below freezing. We shall find then that the crystallization will begin at all sides of the globe, and proceed gradually towards the centre, expelling before it all the air, and most of the foreign substances which may be contained in the water. If the cold be continued, the portion of water last frozen will be found in the middle, until finally the process will end by collecting at this point a quantity of air surprising in amount. Before,

however, this takes place, the glass vessel will be broken by the expansion of the ice. The crystallization at the upper surface of the water will be somewhat irregular at first; the spicula of ice around the margin will tend to shoot out at right angles to the surface of the glass; but after a pellicle has formed over the top of the fluid, this will serve as a point of attachment, and the crystallization will go on, as in the other case, at right angles to the surface; the air bubbles will be driven down before it, and if the freezing be very gradual the air will be entirely expelled, and the ice assume a perfectly transparent and homogeneous structure. If the freezing be more rapid, the air which has been expelled from the higher stratum will be caught by that next below, and in this way we shall have a series of air-bubbles extending downwards to the surface of the unfrozen water.

Accustomed as we are to see bubbles of air rise in the water, it would appear at first sight that the bubbles seen in ice come up from the water below; but from actual observation in the manner we have described, it is clearly proved that the bubbles are composed of air which had been absorbed at the surface of the water, and expelled downwards from stratum to stratum in the process of freezing.

The ice, then, over a lake or pond, consists of crystallized water, of which the axis of crystallization is at right angles to the surface, and the principal cleavage in the same direction. It results from this that, in the thawing of the ice in spring, it tends to resolve itself into innumerable prismatic crystals at right angles to the surface, and is liable to be disintegrated by a strong wind, in a single night, thus producing the phenomena of a sudden disappearance of ice over a large surface, a fact which has been erroneously attributed to its sinking, an evident impossibility, since the minutest portion of crystallized water is specifically lighter than the same substance in a liquid form. General Totten, several years ago, arrived at the same conclusion as to the sudden disappearance of ice, which I have demonstrated in the experiments before mentioned.

Ice, before it tends to give way, becomes pervious to water, which is readily transmitted through the interstices of the crystals; hence, those who are accustomed to travel upon frozen lakes or rivers are aware of the fact that so long as the water of the melted snow does not pass through the surface of the ice underneath, it is safe and in a sound condition, though we must be careful not to confound this water with that forced up by hydrostatic pressure from below, on account of the bending downwards of the whole field.

A simple method has been proposed for determining the relative severity of different winters, by observing the thickness of ice. For this purpose, a shallow vessel of water is exposed to the air, and the thickness of the ice produced measured each day. From what we have said, it is necessary, first, that the vessel be made of wood or some other non-conducting substance, in order that the freezing may not take place at the sides; and, second, that the water be always of the same depth; for if there be two vessels of the same diameter, but one contains more water than the other, the thickness of ice will be different, unless the fluid in both is at the temperature of *thirty-two*

degrees at the commencement of the exposure. If we would ascertain more accurately the measure of effect, the ice must be broken, and its thickness measured or the amount weighed very carefully every day; for if we suffer it to accumulate, we shall have a less result, since the first coat tends to screen the water, so that with the same temperature the process goes on more slowly. This method is very simple, and, when properly employed, furnishes reliable data for determining the relative intensity of different winters. By simply measuring the thickness on a lake or pond, from year to year, we may approximately arrive at a similar result. But, as we have said, the upper stratum screens the lower ones, and a knowledge of this fact has been taken advantage of in some parts of New England to increase the quantity of the ice for economical purposes. To this end, water is suffered to flow over a surface of ice already frozen, and thus, by frequently repeating the operation, a much greater aggregate thickness of ice is produced. From what we have said, however, it must be evident that ice made in this way is more porous, and contains more air than that formed by ordinary freezing, since all the air evolved from the strata after the first must be retained by the next below.

The more solid the ice, the longer it will resist thawing; first, because it contains more water under a given external surface, and, second, because a portion of radiant heat is always absorbed at any surface, whether it be external or internal; for example, if we expose a piece of ice containing a bubble of air to a source of radiant heat, we shall find that the bubble will gradually enlarge, thus proving an internal melting to be going on. In the preservation of ice for domestic purposes it is therefore important that it should be gathered in masses as thick and large as possible. The lower side of the ice, as a general rule, will contain more impurities than the upper, since the process of crystallization tends to expel all the foreign ingredients downwards; and hence a storehouse filled with thin ice will contain more impurities, and, on account of the multitude of bubbles and amount of surface exposed, will melt much sooner than if well packed with thicker blocks. The temperature of ice, moreover, may be reduced considerably by exposure for some time to the weather, when below the freezing point, and thus the value of its cooling effect be enhanced. This diminution of free caloric, however, is only continued by the slow conducting power of the ice, and though it may retard considerably the melting of the mass, we think the effect is scarcely perceptible in ice transmitted to warmer climates. We have never found a thermometer, inserted in a hole in the centre of blocks of Boston ice, in the city of Washington, to sink below 32°. In filling the ice-house, however, and in compacting the mass, advantage should be taken of the coldest weather.

In the preservation of ice the smaller the amount of surface exposed between the several parts, and the greater the amount accumulated in a given place, the longer it will resist melting; for the tendency to become liquid will be in proportion to the surface exposed, since the heat which produces this effect must pass through the sur-

face; for example, in a cubic block of ice, containing one cubic foot, there are six surfaces exposed, each one foot square, namely, the four sides and two ends. Now, if we cut this same block into two parts, by a plane parallel to one of the sides, we shall present two additional superfices each a foot in extent, and the aggregate amount of surface exposed will be increased in the ratio of six to eight. For a similar reason, if we have two ice-houses of like form, the one ten and the other twenty feet in diameter, the capacity will be in the ratio of one to eight, while their surfaces will be as one to four; hence the tendency to resist melting will be in direct proportion to the diameters of reservoirs of similar forms.

Of all geometrical solids, a sphere is that which contains the greatest amount of space in a given surface. All other conditions being equal, we should choose this form of excavation for preserving ice; but on account of the difficulty of lining a pit of this shape, we may select the next most economical form, which is the cylindrical. It is scarcely necessary to mention, in this connection, the fact that, in order to succeed in preserving ice, it should be well protected from the surrounding earth and air by strata of non-conducting materials, such as straw, powdered charcoal, or saw-dust, the greater the thickness of which, the better the purpose in view will be answered. The house should also, as an additional precaution, be shaded above by trees, and have the cover painted white, to reflect off the more intense rays which may reach it indirectly. Moreover, the ice should not be suffered to rest upon the bare ground below, but on a double flooring, between which a non-conducting substance is placed, communicating by holes with a deep pit or drain through which the water from the melted ice may percolate.

We have stated that water at 39°.1 begins to expand, and that this expansion increases until solidification takes place. The force exerted on this expansion is immensely great, being sufficient to burst a cannon, or to cause water to pass in the form of a fine frost through the pores of solid metal. When, however, this expansion is opposed by a sufficient external pressure, the water is not converted into a solid at thirty-two degrees, but assumes this condition at a lower temperature; a piece of ice, therefore, at thirty-two degrees, subjected to a great pressure, ought to be converted into a liquid; and this may serve to explain a fact frequently noticed, that pieces of ice thrown upon each other adhere at the points of contact—the percussion changing these from a solid to a liquid, which immediately afterwards solidifies again. But this cause is scarcely sufficient to explain the very remarkable fact, that if two lumps of ice be placed so as to present two flat surfaces, and these be pressed together, they will unite as one mass; and this will take place even in hot water while the external surface is rapidly melting. The pressure necessary to bring them into contact would, no doubt, tend to produce the effect we have already mentioned, though it is not improbable that the melting of the ice, as in the case of the evaporation of water, tends to reduce the temperature slightly below 32°. Mr. Tyndal, of the Royal Institution, has recently made an interesting series of experi-

ments on the plasticity of ice. He finds that it may be bent and moulded into a variety of forms by subjecting it to pressure, particularly when near the melting point, and has very ingeniously applied this property to the explanation of the stratified appearance of some of the glaciers. If pressure is applied to any plastic substance in which are disseminated globules of air or irregular patches of other material, the mass will assume a lamellar structure at right angles to the direction of the compressing force; and in this way, the laminated appearance which is exhibited after the confluence of two separate streams of ice, which exert a great pressure upon each other, is explained.

It is well known that when alcohol and water are mixed together the attraction of the two bodies is so great that a diminution of bulk, and a consequent rise of temperature, ensue. The same affinity exists between ice and alcohol; but when these are mixed, strange to say, a considerable *diminution* of temperature is the result; and those who habitually or otherwise mingle these two ingredients as a beverage, are sometimes surprised to find the fragments of ice frozen in a solid mass to the spoon by which the mixture is stirred. When two liquids having an attraction for each other are mingled together, and a diminution of bulk ensues, heat must be evolved, on account of the power generated by the approach of the atoms. For an analogous reason, when the attraction between the atoms of two bodies is diminished, a quantity of heat must disappear; hence, when a solid is dissolved in a liquid for which the attraction is not very intense, a quantity of heat disappears, or cold is the result. In the case of the alcohol and ice, the cold produced by the liquefaction of the solid greatly exceeds the heat which might be produced by the union of the water and the alcohol. When the affinity, however, is very great, as between nitric acid and copper, then the heat of the chemical combination of the two substances far exceeds the cold due to the liquefaction of the solid, and a high temperature in the mixture is the result. On the same general principle is explained the melting of ice by sprinkling the surface of it with salt—a process sometimes resorted to for clearing the sidewalks after an intense cold has succeeded rain.

The union of salt and ice produces a liquid which freezes many degrees below the solidifying point of water; and hence, when they unite in a solid state by their surfaces a liquefaction must necessarily ensue, provided the union takes place at 32° ; and this, in accordance with the general law, must be attended with a great reduction of temperature in the surrounding bodies, on which depends the application of salt and snow to artificial freezing, as in the manufacturing of ice-cream. In places where ice is scarce, the same principle may be applied to produce a much greater reduction of temperature from a smaller quantity of this substance. Three parts of ice and one of salt mixed together in a thin vessel will reduce the temperature of a large quantity of water; and since the same salt may again be obtained in a solid form by exposing the solution to the sun, we think the freezer might in some cases be economically employed.

The artificial production of ice in hot countries on a scale sufficient for domestic use, has, it is said, of late been successfully accomplished.

An attempt of this kind was made a few years ago at New Orleans, by means of the rapid evaporation of water, but the cold produced in this way being small, the process was not sufficiently economical to enable the manufactured article to compete in price, in that city, with the abundant supply of ice imported from New England.

Another process, which is said to be more effectual, is that of a Mr. Harrison, of England, and consists in the evaporation, liquefaction, and re-evaporation of ether. If the bulb of a thermometer covered with cotton and wet with ether be exposed to the atmosphere, the cold produced by evaporation will cause the mercury to descend many degrees below the freezing point; and if the evaporation be made to take place under the receiver of an air pump, a much greater reduction of temperature will be produced.

Although we have not seen any account of the apparatus for reducing to practice the plan above referred to, we can readily imagine an arrangement which would produce the result. For this purpose, it would be sufficient to put the water to be frozen in thin vessels, tightly closed, and place them in a large receiver containing ether, the latter being connected with an air pump, of which the upward stroke should exhaust the atmosphere, and the downward stroke recondense the vapor in a separate vessel, to be again let into the freezing receiver, and so on.

The establishment of the ice trade, for which the present age is chiefly indebted to an enterprising citizen of Boston, must have a beneficial effect upon the sanitary condition of the world. The white man is especially adapted by his physical organization to the temperate regions, and succumbs to the intensity of the prolonged heat of the tropics, unless, through the agency of science, he is enabled to ameliorate the effects of the ardent rays of a nearly vertical sun. An abundant supply of ice not only adds to the comfort of the European in India, but is indispensable to the continuance of his health. The use of this article will probably be very much extended, and by a suitable system of ventilation applied to the cooling of the air of apartments in a manner analogous to that of heating them during the rigor of winter at the North.

The expansion of a quantity of water passing into a solid state will be in the direction of least resistance, and hence we find a bulging up in the centre of the ice in a pitcher; but if the freezing be continued, the thickening of the ice in this direction will produce a reaction in other directions, which causes the rupture of the vessel. This expansion, as we have stated before, only takes place while the water is in the act of solidifying; and it is not the stratum of ice first formed which causes the bulging up in this case, but the expansion of the water beneath. This is fully explained by the plastic character of ice before mentioned. If the bulging up, however, be too great, cracks are produced at the most elevated parts.

After a quantity of water has been solidified, it ceases to expand; and, with a still further diminution of temperature, shrinks, in accordance with the law to which all solid bodies are subjected. Indeed, it is now known that all liquid substances which pass into the solid

state enlarge their volume at the moment of transition, and that the phenomenon exhibited by ice is only a conspicuous illustration of a general rule. Ice once formed is found to shrink more rapidly with a diminution of temperature than any other substance on which experiments have yet been made.

The expansion of water and shrinking of ice serve to explain a variety of phenomena presented in the operations of Nature and the processes of the arts. Those who reside near the borders of rivers or fresh-water lakes are often startled during cold winter nights by explosions apparently as loud as those of discharges of heavy ordnance. These are produced by the rupture of long lines of ice—the gradual shrinking which has been going on during the reduction of temperature tending to bring the whole mass into a state of tension, which is relieved by the sudden giving way along the line of least strength. I am informed by Captain Meigs, who has paid particular attention to the cracking of ice on Lake Champlain, that it most frequently takes place in the narrower parts of the lake—the shrinking of portions on each side of this line of least resistance tends to separate the two masses. The water sometimes rises in the cracks thus formed, a new freezing takes place, and when the weather moderates and the field expands to its original dimensions, it becomes too large for the area it covers, and long lines of ridges are thrown up.

A similar effect is sometimes produced on the surface of damp ground subsequently frozen. During the winter of 1856 and 1857, we received accounts of injury done to several brick houses by the separation due to the shrinking of the surface, passing through the foundation of the edifice, and extending up along the walls. We might infer, from the principles already stated, that the line of separation would, in preference, pass through a house, as this is the direction of least resistance, for the cellar may be considered as a line of fissure between the two masses of earth, or a crack already commenced.

During a very cold night, when the temperature is rapidly diminishing, and the ground covered with snow, slightly encrusted on the surface by previous thawing and freezing, a continued series of minute explosions may be heard, depending in frequency and loudness upon the thickness or thinness of the crust. In some cases, it resembles a crackling, and at others a series of distant, though not loud or sharp explosions.

There is a phenomenon connected with ice, in rivers, which has given rise to much discussion as to its cause. I allude to the freezing which takes place at the bottom of running streams, where, in some cases, it remains until it is separated by its buoyancy and rises to the surface. It presents a peculiar angular appearance, and is sometimes known by the name of *anchor ice*. Its formation appears to be an exception to the general rule of the freezing of water, which, on account of the decreasing density, usually takes place at the surface. It was at first supposed that it was due to the radiation of heat through the clear water above; but Arago has shown that this explanation cannot be the true one, since rays of low temperature cannot

pass through water, and hence no such radiation can take place. A more probable explanation has been given, I think, by the same author, in referring it to the fact that still water can be reduced below the freezing point without congealing, and that it will immediately be converted into ice if a bit of solid matter be thrown into the vessel in which the experiment is made, which may serve as a nucleus for the crystallization. When water in this state is passing through a rapid channel, it is mixed together, and the coldest as well as the warmest part is brought into contact with the bed of the stream, the materials of which, acting as a point of rest, serve as a basis of crystallization.

Peculiar mechanical effects are sometimes produced by alternations of thawing and freezing—as, for example, in the case of water pipes constructed of lead or other malleable metal. To render this plain, let us suppose a lead pipe one foot in length to be filled with water, and, after being hermetically sealed at each end, exposed to a low temperature; the expansion would merely stretch the pipe, the extension not being sufficient to burst it, and no continuation of cold or increase of its intensity would produce any further effect, as this would merely cause the ice to shrink; neither would thawing and refreezing produce any effect, since the water would merely return to its original volume, and the ice again expand to the same extent as before; but if the pipe communicated with a reservoir of water, so that when the thawing took place, the whole space, enlarged by the previous freezing, were again filled with water, a second freezing would produce another enlargement of its internal capacity, and a third thawing and freezing, under the same circumstances, would repeat the process, until at length the sides of the tube would give way.

Plants filled with sap and exposed to a low temperature, are variously affected, according to the character of the plant, the duration of cold, and the season of the year at which it occurs. A sudden cold will tend to burst the cells. The velocity of the motion of the sap depends principally on the amount of evaporation from the leaves and stems, and this diminishes with temperature, all other things being the same; hence there is a certain degree of cold at which the sap ceases to flow, and the functions of the plant are suspended.

The different parts of the same plant are killed at different temperatures below thirty-two; the more succulent and tender suffer first, and the woody, or that in which the sap is better defended by non-conducting materials, last. A sudden fall of temperature, even if it be extreme, if of short duration, may not penetrate to the sap and produce freezing. It would also appear that the sap of different plants congeal at different temperatures, and it is highly probable that other changes than those of a mechanical character are produced; but on this subject much research is required, and every intelligent farmer may add important materials to our stock of knowledge by carefully recording the observations he may make relative to the reduction of *temperature* and its continuance by which certain plants are destroyed.

It is shown by repeated observations that alternations of freezing and thawing are more hurtful to the tender plant than a uniform continuation of cold; whether this is produced by an action analogous to that we have described in reference to the water-pipe, or is due in part to this and other changes, we are unable to say. When, however, the sap of a plant, killed by frost, is examined with a microscope, we find in it portions of destroyed tissue. It has also been observed that air may sink a few degrees below the freezing point without injury to the plant, provided the air at the time be very dry. It would seem from this that the freezing of the vapor, and the production of the minute crystals which constitute hoar frost, are, in a degree, essential to the effect.

As a general deduction from chemical and mechanical principles, we think no change of temperature is ever produced where the actions belonging to one or both of these principles are not present. Hence, in mid-winter, when all vegetable functions are dormant, we do not believe that any heat is developed by a tree, or that its interior differs in temperature from its exterior further than it is protected from the external air. The experiments which have been made on this point, we think, have been directed by a false analogy. During the active circulation of the sap and the production of new tissue, variations of temperature belonging exclusively to the plant may be observed; but it is inconsistent with general principles that heat should be generated where no change is taking place.

All animals, so long as life continues, generate heat, and have temperatures peculiar to themselves. In the higher class of air-breathing animals this temperature varies within comparatively slight limits under the influence of motion, rest, or of external circumstances; and a reduction of temperature by the application of external cold, produces, as it is well known, a sluggish condition, which finally terminates in death. The effect of external cold can be prevented by artificial covering, or it may be obviated, in the case of domestic animals, by an extra allowance of food. The sagacious farmer is aware of the fact that a well-sheltered enclosure for cattle is not only a humane, but an economical provision.

Many observations have been made on the temperature peculiar to different animals, and a considerable number of observations recorded of a less scientific character in regard to the effect of the variations of temperature to which they may be subjected without permanent injury. The most astonishing fact, and one which could scarcely be believed, if we were not in this country familiar with it, is, that many cold-blooded animals can be actually frozen, and be to all appearance dead, and yet be revivified by gradually thawing in water near the freezing point.

Fish, as we are assured on reliable authority, are often brought to our Northern markets from a great distance in a frozen condition, and may be restored to life by the process we have mentioned.

This is a subject, as it appears to me, of high interest in a physiological point of view, and would richly repay the application of well-devised systems of investigation. Can it be possible that the

animal is frozen entirely through, and that every vital act is suspended? To what degree can a like result be produced on warm-blooded animals, and how far can the state of hibernation be prolonged without death to the individual? Will it ever be possible, in the case of the higher mammalia, to so maintain the unstable equilibrium as to prevent decay, and, at the same time, to preserve, as it were, in a latent state the vivifying principle? Though investigations on this point would be interesting, we can scarcely hope to realize from them one of the fancies of Dr. Franklin, that of sending representatives of one age down to another to keep alive more actively the sympathies of the present with the past?

The depth to which ground is frozen in some places, from year to year, is also an indication of the severity of the seasons; the effect of cold, however, will penetrate very differently in dry or moist soil; in the first it will depend entirely on the conducting power of the material, and in the second, it will also depend upon the amount of water to be congealed. The conducting capacity being the same, the depth to which the given degree of cold will penetrate will be much greater in dry than in wet soil, on account of the great amount of latent heat given off by the water before it is solidified. In dry conducting soil, the propagation of cold downwards may continue some time after the surface of the ground has become considerably heated.

In a conducting body, all parts tend to an equilibrium of temperature. If the upper end of a vertical iron bar be heated, and then removed from the source of heat, it gradually becomes cooled, while the other parts increase in temperature, until gradually an equilibrium is established; conversely, if we cool the upper end of the bar, it will take heat from the next lower part; and this from the next, and so on, until the cooling reaches the extreme end, which will be cooled last. If, before the cooling has reached the lower end, we heat the upper part, the next below will be heated, and so on, proceeding downwards; thus waves, as it were, of heat and cold may be sent through the length of the bar, becoming less and less in intensity as they descend. In this way explanations have been given of the phenomenon of caverns colder in summer and warmer in winter—the cold wave due to a lower temperature requiring six months to reach the point of observation.

The freezing of the ground in certain soils is hurtful to vegetation; the frozen stratum, expanding irregularly from below, heaves up the surface, and frequently loosens or breaks the roots of the plant. A covering of snow is a protection, since this substance, from its flocculent nature and the air entangled in it, is a bad conductor of heat. As a general rule, during cold weather a thermometer in air on the snow will exhibit a lower temperature than one under the same material at the surface of the ground. This effect, however, is not entirely due to the screening influence of the covering, but in part to the fact that the intense rays of the heat of the sun, as well as those of the light of the same body, penetrate the crystals of the snow as they do the glass covering of a hot-house, and, absorbed by the dark ground beneath, elevate the temperature. For the same reason in

bright days the snow next the slate roof of a house is seen to melt, while the upper surface remains unaffected.

There is a singular phenomenon observed during the spring of the year in damp, sandy places, which has attracted much attention, namely, the ice-columns which spring from the earth during cold nights, elevating small gravel-stones on their tops, and raising, as it were, above its usual level the general surface of the ground. These crystals have been carefully studied by Professor John Le Conte, and appear to be due to the law we have before mentioned of the axis of crystallization being always at right angles to the surface of cooling, as well as to the attraction of the water for itself, and the consequent excluding effect of all extraneous bodies. The water of which these crystals are formed is drawn up from below by capillarity; is frozen as it comes up to the surface in vertical prismatic crystals; a new portion is drawn between the bases of the crystals first formed and the ground, which is also frozen; and so on the process is continued until stopped by the failure of moisture, or the increase of the temperature due to the advancing heat of the day.

The next subject in order, of which we intended to treat, was that of the vapor of water in the atmosphere; but this is of so important a character in its connection with all the phenomena of the fitful changes of the weather, and the peculiarity of climate, and agricultural products of a country, that justice cannot be done to it within the limits assigned to meteorology in this Report, and therefore we shall defer it until next year.

MEAN AND EXTREME TEMPERATURES, WITH THE AMOUNT OF RAIN FALLEN AT DIFFERENT POINTS, DURING THE YEAR 1857.

AIKIN, SOUTH CAROLINA.

Latitude, 33° 32′ N.; longitude, 81° 34′ W. Elevation above tide-water, 565 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7 ; earliest frost in autumn, November 19 ; period without frost, 225 days. Observer, JOHN H. CORNISH.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	35.73	58.86	51.58	55.69	68.85	77.50	76.40	79.86	75.13	61.87	52 66	51 23	62.11
Therm'r extremes.	60	76	82	73	86	92	86	92	90	78	83	74	....
	4	33	24	28	50	66	64	69	53	4	19	31	....
Rain, inches........	3.99	0.70	3.18	2.23	4.11	2.22	5.15	6.95	0.17	0.81	1.97	4.34	38.15

ALEXANDRIA, VIRGINIA.

Latitude, 38° 48′ N.; longitude, 77° 01′ W. Elevation above tide-water, 56 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 6 ; earliest frost in autumn, October 22 ; period without frost, 198 days. Observer, BENJAMIN HALLOWELL.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	23.59	42.23	40.79	47.51	63.38	74.04	76.31	75.65	67.34	55.75	45.50	42.93	54.59
Therm'r extremes.	40	75	71	70	84	90	89	91	84	74	79	74	....
	— 6	11	12	27	42	55	58	60	48	32	15	22	....
Rain, inches........	3.05	0.49	0.88	2.42	4.45	4.85	4.54	5.00	2.26	2.30	1.93	5.44	37.66

AMHERST, MASSACHUSETTS.

Latitude, 42° 22′ N.; longitude, 72° 34′ W. Elevation above tide-water, 267 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 8 ; earliest frost in autumn, September 7 ; period without frost, 151 days. Observer, Professor E. S. SNELL.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	13.50	31.46	31.34	41.04	56.75	63.30	70.63	67.23	59.83	48.63	38.90	31.62	46.18
Therm'r extremes.	37	62	54.5	58	86	81	90	90	86	73	67	52	....
	—18	— 3	4	14	40	49	53	54	32	25	13	2	....
Rain, inches........	3.54	2 40	2.12	7.68	6.81	2.66	4.98	3.14	3.03	3.87	2.06	5.31	47.66

ANNAPOLIS, MARYLAND.

Latitude, 38° 58′ N.; longitude 76° 29′ W. Elevation above tide-water, 20 feet. Hours of observation, 7 A. M. and 2 and 9 P. M Latest frost in spring, April 7 ; earliest frost in autumn, October 21 ; period without frost, 196 days. Observer, WILLIAM R. GOODMAN.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	23.16	39.60	38.31	44.81	62.07	71.24	75.58	74.92	68.76	55.88	44.70	42.20	53.44
Therm'r extremes.	41	69	60	68	82	90	90	93	89	71	71	60	....
	— 7	9	10	25	43	55	56	59	43	31	15	20	....
Rain, inches........	2.97	0.77	1.67	3.68	6.32	8.89	6.19	7.98	1.53	3.43	1.77	6.44	51.64

AUGUSTA, ILLINOIS.

Latitude, 40° 12′ N.; longitude, 87° 45′ W. Elevation above tide-water, 200 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 19; earliest frost in autumn, October 20; period without frost, 183 days. Observer, S. B. MEAD, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	11.59	33.96	32.43	39.49	57.61	68.40	76.21	71.56	66.57	50.27	33.79	35.03	48.07
Therm'r extremes.	45	62	68	69	85	88	98	92	88	75	63	56	....
	—23	—8	—2	15	36	52	58	50	41	24	—2	17	....
Rain, inches........	0.39	4.80	2.55	0.88	2.03	3.70	1.44	4.10	2.72	2.32	2.43	1.36	28.75

BATTLE CREEK, MICHIGAN.

Latitude, 42° 20′ N.; longitude, 85° 10′ W. Elevation above tide-water, 750 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 20; earliest frost in autumn, October 3; period without frost, 165 days. Observer, W. M. CAMPBELL, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Thermometer, mean.	14.01	32.37	30.68	38.43	54.58	66.21	72.61	70.24	63.82	47.59	32.24	33.08	46.32
Therm'r extremes.	36	58	58	68	85	90	92	90	69	71	62	54	....
	—26	—3	—2	18	34	48	56	53	41	26	—16	6	....
Rain, inches........	1.12	5.83	1.15	1.73	3.13	3.26	4.87	4.40	1.18	1.05	2.31	1.20	31.23

BELLEVUE, IOWA.

Latitude, 42° 15′ N.; longitude, 90° 25′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 28; earliest frost in autumn, September 23; period without frost, 147 days. Observer, JOHN C. FORY.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	4.26	26.46	27.17	35.61	54.54	68.45	74.89	69.68	64.38	48.86	29.95	30.59	44.57
Therm'r extremes.	37	46	58	60	84	88	97	92	87	75	60	52	....
	—32	—14	—8	16	33	46	52	50	33	20	—6	12	....
Rain, inches.... ...	0.95	4.80	1.90	1.83	4.19	3.92	3.51	5.27	2.47	2.47	3.57	1.17	36.05

BELOIT, WISCONSIN.

Latitude, 42° 30′ N.; longitude, 87° 04′ W. Elevation above tide-water, 750 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 12; earliest frost in autumn, October 19; period without frost, 159 days. Observer, Professor WILLIAM PORTER.

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	6.92	27.76	28.59	36.32	52.66	65.25	72.97	67.78	62.38	47.34	29.95	31.37	44.11
Therm'r extremes.	40	52	64	66	84	90	93	98	86	75	61	52	....
	—25	—8	—6	12	29	46	57	53	33	23	—20	15	....
Rain, inches........	?	?	1.33	2.80	4.23	4.35	2.63	5.42	1.91	3.91	1.92	1.05	?

BERRYVILLE, VIRGINIA.

Latitude, 39° 09′ N.; longitude, 78° W. Elevation above tide-water, 575 feet Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7 ; earliest frost in autumn, September 7 ; period without frost, 152 days. Observer, Miss ELLEN KOUNSLAR.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	21.77	40.62	37.96	43.59	58.80	69.87	70.15	70.81	63.70	52.63	41.50	38.71	50.84
Therm'r extremes.	39	67	71	66	79	86	88	91	89	72	76	60	....
	0	12	13	24	40	57	54	55	41	31	11	22	....
Rain, inches........	2.95	0.99	1.72	3.03	5.86	6.20	3.98	3.01	1.81	1.03	1.73	5.70	38.01

BRIGHTON, ILLINOIS.

Latitude, 39° N.; longitude, 90° 13′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 20 ; earliest frost in autumn, September 23 ; period without frost, 155 days. Observer, WILLIAM V. ELDRIDGE.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	15.24	37.85	35.08	37.31	60.60	76.52	85.40	83.95	72.09	52.63	31.57	33.79	51.85
Therm'r extremes.	42	71	68	64	89	92	106	99	89	81	59	61	....
	—20	0	7	19	34	50	68	70	35	27	1	16	....
Rain, inches........	1.23	2.40	1.70	1.40	1.40	2.40	1.00	1.50	0.70	0.40	2.30	1.30	17.73

BURLINGTON, NEW JERSEY.

Latitude, 40° N.; longitude, 75° 12′ W. Elevation above tide-water, 26 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 8 ; earliest frost in autumn, November 4 ; period without frost, 209 days. Observer, E. R. SCHMIDT, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	20.26	37.92	36.85	43.29	58.91	67.15	72.84	71.66	64.69	54.33	42.72	38.13	50.75
Therm'r extremes.	39	66	61	65	81	83	90	91	83	74	75	61	....
	—15	6	7	20	43	53	54	56	43	34	14	17	....
Rain, inches........	4.25	2.96	1.92	6.03	5.70	6.55	5.88	6.76	1.80	3.24	1.50	5.18	51.80

CAMDEN, SOUTH CAROLINA.

Latitude, 34° 17′ N.; longitude, 80° 33′ W. Elevation above tide-water, 275 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 25 ; earliest frost in autum, October 1 ; period without frost, 158 days. Observer, J. A. YOUNG, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	32.14	55.14	47.67	54.26	67.63	77 24	76.00	77.84	73.79	58.03	50.76	48.89	59.95
Therm'r extremes.	59	78	80	78	85	95	90	95	93	79	90	77	....
	0	22	16	35	51	64	63	65	47	37	17	22	....
Rain, inches........	4.07	1.33	3.18	2.63	3.83	2.67	6.90	8.96	0.90	1.30	1.08	4.83	41.68

CANONSBURG, PENNSYLVANIA.

Latitude, 40° 25′ N.; longitude, 80° 07′ W. Elevation above tide-water, 936 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 24; earliest frost in autumn, October 1; period without frost, 179 days. Observer, Professor WILLIAM SMITH.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	17.79	41.58	35.81	39.81	56.25	65.48	69.76	69.39	65.19	50.60	38.87	34.66	48.77
Therm'r extremes.	40	67	68	65	80	82	86	86	85	71	76	58	....
	—6	12	8	18	38	48	55	57	44	32	11	26	....
Rain, inches........	1.55	1.91	1.29	2.16	5.73	5.48	4.45	4.48	2.91	3.61	3.73	3.50	40.83

CARLOWVILLE, ALABAMA.

Latitude, 32° 10′ N.; longitude, 87° 15′ W. Elevation above tide-water, 300 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7; earliest frost in autumn, November 20; period without frost, 226 days. Observer, H. L. ALISON, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	38.86	59.31	53.20	58.11	69.74	78.98	77.93	79.24	75.05	61 64	52.40	55.19	63.30
Therm'r extremes.	66	80	79	80	88	96	92	91	89	81	78	80	....
	8	27	30	32	52	60	62	70	59	42	26	38	....
Rain, inches........	4.77	2.10	4.87	4.88	6.75	2.05	4 96	6.92	1.32	0.85	3.90	3.87	47.44

CHARLESTON, SOUTH CAROLINA.

Latitude, 32° 46′ N.; longitude, 80° W. Elevation above tide-water, 30 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, March 3; earliest frost in autumn, November 20; period without frost, 267 days. Observer, JOSEPH JOHNSON, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	40.75	58.39	53.61	58.31	71.03	79.38	78.30	80.15	76.02	63.31	57.87	57.46	64.55
Therm'r extremes.	66	77	79	76	87	92	88	92	87	77	8	74	....
	14	34	27	37	54	70	64	68	57	46	20	39	....
Rain, inches........	1.60	1.35	2.50	3.95	2.25	2.86	9.57	2.25	1.21	2.32	2.87	5.36	38.12

CHROMEDALE, PENNSYLVANIA.

Latitude, 39° 55′ N.; longitude, 75° 25′ W. Elevation above tide-water, 196 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 16; earliest frost in autumn, September 24; period without frost, 160 days. Observer, JOSEPH EDWARDS.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	20.07	37.16	34.96	42.20	58.95	68.52	73.79	70.87	63.46	52.52	40.83	37.83	50.10
Therm'r extremes.	36	66	60	63	83	84	89	89	79	72	74	62	....
	—17	4	9	21	40	51	55	56	40	28	11	13	....
Rain, inches........	2.66	1.38	1.55	5.65	5.33	6.39	1.97	8.26	1.03	3.72	1.51	5.69	45.14

CINCINNATI, OHIO.

Latitude, 39° 06′ N.; longitude, 84° 27′ W. Elevation above tide-water, 540 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 17; earliest frost in autumn, November 10; period without frost, 206 days. Observer, GEORGE W. HARPER.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	21.42	43.57	40.40	44.68	61.31	71.76	77.84	76.47	71.58	55.82	42.17	41.83	54.07
Therm'r extremes.	44	75	78	77	92	91	95	92	91	80	71	63	....
	−10	10	12	21	38	56	57	58	45	33	12	25	....
Rain, inches........	0.53	1.98	0.76	2.72	5.53	3.08	2.50	2.92	0.75	4.92	5.36	3.82	34.88

CRAFTSBURY, VERMONT.

Latitude, 44° 40′ N.; longitude, 72° 30′ W. Elevation above tide-water, 1,100 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 12; earliest frost in autumn, September 19; period without frost, 129 days. Observer, JAMES A. PADDOCK.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	5.03	23.89	23.24	35.57	50.03	57.81	67.26	62.06	55.35	43.57	32.97	22.73	39.96
Therm'r extremes.	30	56	48	54	79	76	87	81	80	63	61	40	....
	−34	−21	− 6	2	26	43	52	50	34	26	− 2	− 8	....
Rain, inches........	2.90	3.31	2.53	4.75	4.00	5.68	5.16	5.95	2.23	4.54	2.25	3 80	47.10

CRICHTON'S STORE, VIRGINIA.

Latitude, 36° 40′ N.; longitude, 77° 46′ W. Elevation above tide-water, 500 feet. Latest frost in spring, April 25; earliest frost in autumn, October 1; period without frost, 158 days. Observer, Lieutenant R. F. ASTROSS.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	31.57	52.59	47.83	52.56	67.57	80.08	78.40	80.25	71.71	59.36	50.59	48.95	60.12
Therm'r extremes.	50	77	71	74	88	99	91	98	92	74	82	74	....
	8	25	26	32	45	59	58	62	51	38	23	30	....
Rain, inches........	0.90	0.31	1.55	2.30	4.05	3.09	11.46	1.06	3.68	1.50	1.22	2.97	34.09

EASTON, PENNSYLVANIA.

Latitude, 40° 43′ N.; longitude, 75° 16′ W. Elevation above tide-water, 320 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 17; earliest frost in autumn, October 22; period without frost, 187 days. Observer, SELELEN J. COFFIN.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	16.22	34.52	35.87	42.60	56.62	65.34	71.57	69.04	61.82	50.24	38.34	34.63	48.07
Therm'r extremes.	36	66	62	64	84	86	89	87	84	73	72	54	....
	−14.5	4	10	19	39	51	52	51	36	31	9	7	....
Rain, inches........	3.32	1.70	1.04	5.74	7.34	5.76	3.94	3.46	1.07	3.15	1.48	5.26	43.26

FLATBUSH, NEW YORK.

Latitude, 40° 37′ N.; longitude, 74° 01′ W. Elevation above tide-water, 54 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 1; earliest frost in autumn, September 30; period without frost, 151 days. Observer, Rev. R. D. Van Kleck.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	19.32	35.10	34.63	42.17	55.87	65.03	71.23	70.55	63.23	52.29	42.10	37.23	49.07
Therm'r extremes.	37	65	57	58	79	85	87	90	82	73	67	57	....
	—5	77	85	17	42	53	52	56	41	35	19	17	....
Rain, inches........	3.45	1.56	2.14	7.49	6.13	4.57	6.37	3.81	3.48	3.88	1.90	4.94	49.72

FREDERICK CITY, MARYLAND.

Latitude, 39° 24′ N.; longitude, 77° 18′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7; earliest frost in autumn, October 1; period without frost, 176 days. Observer, Henry E. Hanshew.

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	20.35	38 60	36.84	44.46	60.71	71.49	73.69	71.91	64.63	52.66	40.49	38.95	51.23
Therm'r extremes.	38	69	59	65	83	87	84	86	88	73	73	57	....
	-6	35	13	27	41	56	57	55	45	34	14	23	....
Rain, inches........	2.78	0.79	2.29	2.56	7.51	10.72	3.12	2.96	1.27	1.35	1.13	5.76	42.27

GARDINER, MAINE.

Latitude, 44° 11′ N.; longitude, 69° 46′ W. Elevation above tide-water, 90 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 8; earliest frost in autumn, September 7; period without frost, 151 days. Observer, R. H. Gardiner.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	12.70	26.82	30.20	41.65	56.57	61.46	71.38	66.59	59.54	47.92	37.63	24.83	44.77
Therm'r extremes.	35	56	50	58	81	90	90	87	86	70	57	45	....
	—32	—10	—4	19	41	50	56	52	37	24	13	4	....
Rain, inches........	4.22	2.46	4.03	5.30	4.74	3.58	2.33	5.50	1.24	4.97	3.62	4.18	46.21

GETTYSBURG, PENNSYLVANIA.

Latitude, 39° 51′ N.; longitude, 77° 15′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 22; earliest frost in autumn, October 21; period without frost, 181 days. Observer, Professor M. Jacobs.

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	16.82	35.93	34.69	41.99	60.25	69.75	73.53	71.67	64.78	53.25	38.16	35.97	49.73
Therm'r extremes.	40	70	66	72	88	90	91	98	90	87	79	55	....
	—20	—13	6	21	41	53	55	53	41	25	4	16	....
Rain, inches........	30.03	0.97	1.60	3.12	6.23	7.44	5.03	1.97	1.39	1.12	2.34	3.94	38.22

HARRISBURG, PENNSYLVANIA.

Latitude, 40° 16′ N.; longitude, 76° 50′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7 ; earliest frost in autumn, November 15 ; period without frost, 221 days. Observer, JOHN HEISELY, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	20.71	37.77	38.79	45.71	61.88	71.58	77.11	74.51	68.14	55.64	43.47	39.82	52.93
Therm'r extremes.	38	62	60	67	89	91	91	91	86	74	74	54	....
	—12	1	14	26	43	57	58	59	47	36	19	26	....
Rain, inches........	1.25	?	?	2.80	8.03	11.20	3.23	2.93	2.09	1.18	1.00	5.67	?

HILLSBOROUGH, OHIO.

Latitude, 39° 13′ N.; longitude, 83° 30′ W. Elevation above tide-water, 1,000 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 12 ; earliest frost in autumn, September 29 ; period without frost, 139 days. Observer, JOSEPH McD. MATHEWS.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	17.55	41.33	35.16	40.62	56.28	66.04	69.88	69.46	64.44	50.67	37.48	37.92	48.90
Therm'r extremes.	41.5	67	73	69	81	85	87	85	82	66	69	58	....
	—11	5	5.5	20	35	50	53	52	41	32	9	20	....
Rain, inches........	1.73	21.19	1.05	3.03	4.90	5.43	4.92	4.71	0.100	3.99	4.81	3.55	41.23

HIRAM, OHIO.

Latitude, 41° 20′ N.; longitude, 81° 15′ W. Elevation above tide-water, 675 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 18; earliest frost in autumn, September 22 ; period without frost, 126 days. Observer, S. M. LUTHER.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	13.43	38.04	31.68	37.06	53.84	64.62	70.62	67.29	63.88	48.82	34.52	35.80	46.63
Therm'r extremes.	37	64	66	63	84	86	88	85	86	70	65	60	....
	— 9	3	4	18	31	50	53	54	40	30	5	24	....
Rain, inches........	?	3.45	0.80	2.78	3.96	5.80	5.14	2.49	1.54	4.33	4.44	3.32	?

LAWRENCE, MASSACHUSETTS.

Latitude, 42° 42′ N.; longitude, 71° 11′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 8 ; earliest frost in autumn, September 7 ; period without frost, 151 days. Observer, JOHN FALLON.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	17.64	32.97	32.11	31.73	54.19	62.43	70.98	69.34	59.82	48.29	40.23	31.57	45.94
Therm'r extremes.	54	67	55	68	86	82	91	91	86	68	70	52	....
	—25	—6	5	13	36	47	51	51	31	25	13	7	....
Rain, inches........	0.52	2.07	3.48	9.85	4.82	2.86	4.88	6.29	2.65	5.98	2.35	4.84	56.60

LOGANSPORT, INDIANA.

Latitude, 40° 45′ N.; longitude, 86° 14′ W. Hours of observation, sunrise, noon, and sunset. Earliest frost in autumn, October 17. Observer, Charles B. Lasselle.

	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	15	37	34	39	55	66	73	72	66	52	35	36	48
Therm'r extremes.	42	61	64	64	81	89	99	96	87	75	65	60	....
	−19	3	− 2	18	31	41	51	46	39	26	− 1	22	... .
Rain, inches........	1.03	9.01	2.45	0.85	4.50	4.50	2.75	4.38	2.66	2.50	3.24	2.00	39.86

LOWVILLE, NEW YORK.

Latitude, 43° 46′ N.; longitude, 75° 38′ W. Hours of observation, 7 a. m. and 2 and 9 p. m. Latest frost in spring, May 12; earliest frost in autumn, September 7; period without frost, 117 days.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	5.42	20.70	24.80	34.30	48.79	58.17	66.32	62.54	55.40	43.40	35.00	29.10	41.66
Therm'r extremes.	33	52	46	53	84	80	90	84	83	64	70	53	....
	−34	−14	− 6	7	25	40	50	49	32	23	4	− 2	....
Rain, inches........	1.61	4.80	3.14	5.74	3.65	4.35	1.42	4.96	2.75	5.04	5.15	4.69	47.32

MADISON, OHIO.

Latitude, 41° 52′ N.; longitude, 81° W. Elevation above tide-water, 650 feet. Hours of observation, 7 a. m. and 2 and 9 p. m. Latest frost in spring, May 12; earliest frost in autumn, October 8; period without frost, 128 days. Observer, Adelia Cunningham.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	15.90	35.60	32.45	73.61	52.61	64.35	71.47	67.61	62.62	48.56	35.30	35.19	46.60
Therm'r extremes.	40	68	59	70	88	88	95	92	88	70	65	56	....
	− 9	1	7	18	28	46	54	52	40	29	3	18	....
Rain, inches........	1.93	4.44	0.80	4.78	5.00	7.25	6.07	3.26	?	?	8.40	2.78	?

MANCHESTER, ILLINOIS.

Latitude, 39° 33′ N.; longitude, 90° 34′ W. Elevation above tide-water, 683 feet. Hours of observation, 7 a. m. and 1 and 9 p. m. Latest frost in spring, April 23; earliest frost in autumn, September 23; period without frost, 152 days. Observer, John N. Grant.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	14.05	36.24	34.54	40.38	57.84	67.67	74.82	70.97	67.39	51.55	34.86	35.36	48.81
Therm'r extremes.	46	70	74	72	86	90	93	92	86	78	65	58	....
	−22	−4	3	15	35	50	55	52	46	24	1	22	....
Rain, inches........	0.85	6.91	2.62	0.77	2.73	3.84	2.28	4.52	2.39	1.67	3.83	1.35	33.76

MILWAUKIE, WISCONSIN.

Latitude, 43° 04′ N.; longitude, 87° 57′ W. Elevation above tide-water, 593 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 11; earliest frost in autumn, October 19; period without frost, 160 days. Observer, C. WINKLER, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	7.75	27.72	27.03	33.32	49 19	61.01	68.89	67.48	61.04	46.81	29.57	30.71	42.55
Therm'r extremes.	34	49	49	54	84	85	88	93	87	69	57	50	....
	—19	—12	— 3	15	27	44	51	53	39	24	— 3	15	....
Rain, inches........	?	1.85	1.20	3.69	4.60	3.41	3.14	3.01	2.73	2.96	1.50	1.70	?

MEADVILLE, PENNSYLVANIA.

Latitude, 41° 39′ N.; longitude, 80° 11′ W. Elevation above tide-water, 1,088 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 11; earliest frost in autumn, September 23; period without frost, 134 days. Observer, T. F. THICKSTUN.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	13.56	36.23	30.24	36.88	54.39	64.82	72.02	56.77	62.36	48.50	34.42	34.16	45.36
Therm'r extremes.	40	68	70	64	88	92	94	89	88	72	66	55	....
	—12	— 4	— 3	16	32	45	52	50	40	30	—10	14	....
Rain, inches........	2.32	3.15	1.92	3.70	3.40	8.57	4.39	3.89	1.95	5.40	0.96	4.75	44.35

NORRISTOWN, PENNSYLVANIA.

Latitude, 40° 08′ N.; longitude, 75° 19′ W. Elevation above tide-water, 153 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7; earliest frost in autumn, September 30; period without frost, 175 days. Observer, Rev. J. GRIER RALSTON.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	20.28	37.50	35.97	41.90	56.39	66.33	71.70	69.91	62.80	51.85	41.29	39.10	49.58
Therm'r extremes.	37	66	60	61	81	87	87	88	80	71	74	63	....
	—16	6.5	10	21	40	53	52	53	42	32	14	20	....
Rain, inches........	3.36	0.89	1.46	6.84	6.77	6.00	2.72	6.77	1.71	3.34	1.69	6.00	47.55

MORRISVILLE, PENNSYLVANIA.

Latitude, 40° 12′ N.; longitude, 74° 53′ W. Elevation above tide-water, 30 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 13; earliest frost in autumn, September 30; period without frost, 139 days. Observer, EBENEZER HANCE.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	18.95	36.69	35.49	43.08	57.67	66.23	71.46	69.98	63.47	52.50	42.32	37.53	49.61
Therm'r extremes.	36	70	60	64	82	86	89	90	81	72	73	57	....
	—17	4	7	20	40	54	52	56	44	33	14	14	....
Rain, inches........	2.60	1.00	1.20	6.60	5.80	7.80	4.10	8.00	1.40	2.90	1.20	5.20	47.80

MUSCATINE, IOWA.

Latitude, 41° 26′ N.; longitude, 91° 05′ W. Elevation above tide-water, 586 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, June 5; earliest frost in autumn, October 19; period without frost, 135 days. Observer, T. S. PARVIN.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	6.23	28.99	29.02	36.33	53.20	65.36	71.50	68.88	63.58	47.78	31.67	31.67	44.52
Therm'r, extremes.	41	57	58	65	83	89	97	92	88	74	60	52	....
	—30	—12	— 5	13	29	38	45	47	36	22	0	15	....
Rain, inches........	0.61	5.70	2.44	1.90	2.75	0.90	4.67	6.60	1.88	1.95	3.77	1.88	35.05

NANTUCKET, MASSACHUSETTS.

Latitude, 41° 16′ N.; longitude, 70° 06′ W. Elevation above tide-water, 30 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 3; earliest frost in autumn, November 26; period without frost, 137 days. Observer, WILLIAM MITCHELL.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	23.76	35.86	35.67	42.89	53.41	61.87	68.66	68.44	63.98	54.67	48.91	40.21	49.86
Therm'r, extremes.	46	52	52.5	54	72	76	84	84	80	74	64	56	....
	—6.5	7	16.5	25	41	50	53	58	49	38	22	21	....
Rain, inches........	6.75	2.20	3.97	5.97	4.88	2.90	3.07	7.03	2.51	3.25	2.22	5.14	49.87

NEW BEDFORD, MASSACHUSETTS.

Latitude, 41° 39′ N.; longitude, 70° 56′ W. Elevation above tide-water, 90 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 8; earliest frost in autumn, October 22; period without frost, 196 days. Observer, SAMUEL RODMAN.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	18.58	33.07	32.84	41.24	53.60	62.42	69.57	67.99	61.33	51.99	43.17	35.99	47.65
Therm'r, extremes.	40	57	56	56	81	81	86	88	78	73	66	53	....
	—11	1	10	17	41	53	53	57	38	30	15	11	....
Rain, inches........	5.51	1.64	2.24	5.35	3.29	2.05	4.10	3.50	2.06	2.34	1.64	4.88	38.60

NEWARK, NEW JERSEY.

Latitude, 40° 45′ N.; longitude, 74° 10′ W. Elevation above tide-water, 30 feet. Hours of observation, 7 A. M. and 6 P. M. Latest frost in spring, April 18; earliest frost in autumn, November 12; period without frost, 207 days. Observer, W. D. WHITEHEAD.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	19.33	35.97	35.81	43.40	57.25	65.48	71.76	69.77	62.80	52.59	41.71	24.84	48.39
Therm'r, extremes.	37	68	60	62	81	85	87	89	81	70	73	57	....
	—12	7	8.5	17	36	50	51	51	39	33	16	11	....
Rain, inches........	3.83	1.50	1.99	7.16	6.03	5.35	5.08	4.02	3.81	3.96	0.87	5.79	49.37

NEW HARMONY, INDIANA.

Latitude, 38° 08′ N.; longitude, 87° 50′ W. Elevation above tide-water, 320 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 15; earliest frost in autumn, October 20; period without frost, 187 days. Observer, JOHN CHAPPELLSMITH.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	20.47	45.90	40.00	44.00	61.20	71.47	76.77	75.79	69.89	51.68	41.10	40.85	53.26
Therm'r extremes.	48	69	74	69	84	91	92	91	88	76	71	63	....
	—13	12	14	25	41	56	58	61	47	29	11	26	....
Rain, inches........	1.10	3.49	0.48	2.86	3.35	5.56	3.74	6.60	1.91	0.96	6.81	2.80	39.66

NEW LONDON, CONNECTICUT.

Latitude, 41° 32′ N.; longitude, 72° 03′ W. Elevation above tide-water, 90 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7; earliest frost in autumn, October 21; period without frost, 197 days. Observer, Rev. T. EDWARDS, D. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	18.62	33.80	33.76	42.38	53.87	62.22	69.30	69.98	62.44	52.94	42.62	36.13	48.17
Therm'r extremes.	39	66	55	60	76	82	84	90	83	73	66	59	....
	—16	4	8	18	41	52	53	58	44	32	15	11	....
Rain, inches........	?	?	2.60	6.25	4.61	3.43	6.13	4.66	?	4.18	2.20	4.51	?

NEW LONDON, WISCONSIN.

Latitude, 44° 21′ N.; longitude, 88° 45′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 19; earliest frost in autumn, September 20; period without frost, 124 days. Observer, J. EVERETT BREED.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	4.18	31.54	25.36	35.68	51.13	61.02	71.78	64.98	60.17	43.72	27.51	26.68	41.11
Therm'r extremes.	34	46	56	66	86	92	98	86	86	73	52	42	....
	—28	—23	—10	16	25	42	56	46	37	—23	—11	— 4	....
Rain, inches........	15.75	2.92	?	2.48	2.50	3.61	2.62	2.45	4.38	1.69	1.99	1.85	?

OTTOWA, ILLINOIS.

Latitude, 41° 20′ N.; longitude, 88° 47′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 11; earliest frost in autumn, September 29; period without frost, 140 days Observer, J. O. HARRIS, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	9.76	31.43	29.98	37.10	54.35	66.63	73.98	70.04	63.38	49.07	31.86	33.01	45.88
Therm'r extremes.	39	55	62	60	84	87	93	91	86	75	60	54	....
	—16	— 4	— 7	16	32	44	58	52	35	22	— 4	17	....
Rain, inches........	?	4.45	3.06	1.42	3.65	3.95	3.97	6.10	0.89	2.68	2.95	11.24	

PENN YAN, NEW YORK.

Latitude, 42° 42′ N.; longitude, 77° 11′ W. Elevation above tide water, 740 feet. Hours of observation, sunrise, and 2 P. M. and sunset. Latest frost in spring, May 18 ; earliest frost in autumn, September 20 ; period without frost, 124 days. Observer, H. P. STARTWELL, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	15.09	33.68	30.60	37.75	52.03?	61.49	72.67	65.79	60.77	46.12	38.17	34.44	45.74
Therm'r, extremes.	36	65	54	57	85	85	92	89	87	67	69	54	....
	—18	?	1	11	24	43	49	47	36	23	9	16	....
ain, inches........	0.79	1.13	1.09	4.79	3.37	1.15	2.81	4.87	1.63	6.56	4.21	2.12	44.90?

PEORIA, ILLINOIS.

Latitude, 40° 36′ N.; longitude, 89° 30′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 19 ; earliest frost in autumn, October 20 ; period without frost, 183 days. Observer, FREDERICK BRENDELL, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	13.44	35.06	33.58	40.60	58.90	70.91	78.38	74.27	68.84	52.18	35.19	35.24	49.72
Therm'r, extremes.	43	59	66	72	89	90	99	95	90	78	63	54	....
	—16	—17	—1	18	36	53	59	50	45	25	— 2	18	....
Rain, inches........	0.37	5.32	3.84	1.39	2.80	2.77	1.40	5.61	2.16	2.01	1.28	1.50	30.45

PERRY, MAINE

Latitude, 45° N.; longitude, 67° 06′ W. Elevation above tide-water, 100 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 30 ; earliest frost in autumn, October 1 ; period without frost, 153 days. Observer, WILLIAM D. DANA.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	15.89	26.79	28.43	37.74	48.31	54.90	62.64	60.76	55.66	46.20	36.89	27.40	41 80
Therm'r, extremes.	38	56	49	49	70	70	82	74	80	62	54	46	....
	—19	—10	5	15	33	44	50	50	35	28	9	0	....
Rain, inches........	4.90	6.11	?	7.20	3.50	4.70	3.70	6.40	3.20	7.10	3.60	4.20	?

PERRYSBURG, OHIO.

Latitude, 41° 39′ N.; longitude, 83° 40′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 11 ; earliest frost in autumn, October 20 ; period without frost, 161 days. Observer, D. K. HOLLENBECK.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	16.39	38.19	36.69	41.26	57.42	70.31	75.30	72.00	66.58	50.90	36.50	37.52	49 92
Therm'r, extremes.	48	68	67	66	84	89	92	90	90	74	70	64	....
	—13	4	3	22	32	51	60	52	40	29	— 7	21	....

PHILADELPHIA, PENNSYLVANIA.

Latitude, 39° 57′ N.; longitude, 75 11′ W. Elevation above tide-water, 60 feet Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7; earliest frost in autumn, October 21; period without frost, 196 days. Observer, Professor JAMES A. KIRKPATRICK.

	Jan.	Feb.	Mar.	Ap	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	20.92	39.94	38.02	45.43	61 20	71.20	77.26	75.27	69.17	56.19	45.86	41.03	53.46
Therm'r extremes.	38	68	63	64	86	87	90	94	85	76	77	63	....
	— 5	9	10	23	42	55	56	61	46	36	20	21	....
Rain, inches........	2.99	0.92	1.77	6.93	6.04	7.43	3.37	8.04	1.13	2.74	1.58	5.50	48.45

PLATTEVILLE, WISCONSIN.

Latitude, 42° 45′ N.; longitude, 91° W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 11; earliest frost in autumn, September 30; period without frost, 141 days. Observer, J. L. PICKARD, M.D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	1.85	24.92	28.41	36.66	55.88	58.46	78.05	72.38	65.82	50.63	28.90	30.95	45.24
Therm'r extremes.	36	47	62	66	88	94	102	99	90	75	60	50	....
	—29	—21	—11	12	33	50	60	54	38	23	—10	14	....
Rain, inches........	1.30	2.45	1.48	2.11	4.40	3.97	3.46	3.57	5.08	2.49	2.52	1.99	34.82

POCOSSON, PENNSYLVANIA.

Latitude, 39° 54′ N.; longitude, 75° 37′ W. Elevation above tide-water, 218 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 16; earliest frost in autumn, September 24; period without frost, 160 days. Observer, FENELON DARLINGTON.

	Jan.	Feb.	Mar.	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	19.15	37.65	36.15	42.65	58.45	69.15	74.70	73.22	64.77	52.85	41.84	37.73	50.69
Therm'r extremes.	38	68	60	62	85	90	92	95	84	78	76	60	....
	—19	7	9	22	40	55	54	57	41	32	12	9	....
Rain, inches........	3.87	0.94	2.18	5.28	6.56	5.75	2.51	7.17	1.28	4.14	1.42	5.62	46.72

POMFRET, CONNECTICUT.

Latitude, 41° 52′ N.; longitude, 72° 23′ W. Elevation above tide-water, 596 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 22; earliest frost in autumn, September 7; period without frost, 137 days. Observer, Rev. D. HUNT.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	14.95	32.07	30.86	38.95	52.57	58.84	68.29	65.85	58.77	48.87	39.33	31.11	45.04
Therm'r extremes.	42	64	50	60	81	76	84	85	80	71	66	51	....
	—15	— 3	7	13	37	50	50	54	35	27	12	8	....
Rain, inches........	3.42	?	3.09	6.70	4.71	2.35	5.52	5.48	3.61	3.48	2.94	7.05	?

PORTLAND, MAINE.

Latitude, 43° 39′ N.; longitude, 70° 15′ W. Elevation above tide-water, 87 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 29; earliest frost in autumn, September 30; period without frost, 153 days. Observer, HENRY WILLIS.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	14.06	29.17	30.31	39.82	51.41	61.06	67.40	65.53	59.44	49.10	39.71	30.07	44.75
Therm'r extremes.	38	62	52	56	75	83	84	87	87	68	60	47	....
	—25	—11	5	19	39	48	55	56	35	28	13	11	....
Rain, inches........	6.46	1.68	4.78	5.85	3.42	2.99	5.38	4.94	0.64	6.99	2.39	4 .5	49.66

PRINCETON, MINNESOTA.

Latitude, 45° 50′ N.; longitude, 93° 45′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, June 5; earliest frost in autumn, September 20; period without frost, 106 days. Observer, O. E. GARRISON.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	5.88	12.14	21.41	29.61	53.28	64.75	76.26	69.24	59.81	46.40	25.50	22.72	39.60
Therm'r extremes.	28	40	50	60	84	92	96	93	90	72	52	52	....
	—38	—40	—24	6	26	36	58	51	36	20	—10	— 1	....
Rain, inches........	?	2.34	1.35	3.78	3.42	?	1.04	3.86	3.05	0.79	3.69	?	?

RICHMOND, INDIANA.

Latitude, 39° 47′ N.; longitude, 84° 47′ W. Elevation above tide-water, 800 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 12; earliest frost in autumn, September 23; period without frost, 133 days. Observer, JOSEPH MOORE.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	18.08	40.95	84.37	40.27	55.06	66.17	71.70	71.08	61.90	48.60	36.93	36.63	48.48
Therm'r extremes.	43	66	56	66	81	86	90	87	87	70	65	55	....
	14.5	15	11	19	33	51	54	51	30	26	— 6	18	....
Rain, inches........	0.61	3.88	1.25	1.96	5.99	5.88	1.98	3.48	0.90	3.51	7.38	2.75	39.54

RUTHVEN, VIRGINIA.

Latitude, 37° 21′ N.; longitude, 77° 33′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 21; earliest frost in autumn, October 1; period without frost, 162 days. Observer, JULIAN C. RUFFIN.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	25.78	50.91	41.39	48.95	62.45	73.49	74.76	75.30	69.04	55.08	36.32	42.89	54.69
Therm'r extremes.	44	79	82	71	87	96	91	96	90	76	?	69	....
	—12	30	11	30	43	52	58	58	45	32	?	22	....
Rain, inches........	3.34	0.42	2.18	3.03	6.92	2.63	3.47	2.78	4.72	1.75	1.81	4.07	37.12

SACRAMENTO, CALIFORNIA.

Latitude, 38° 35′ N.; longitude, 121° 40′ W. Elevation above tide-water, 49 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, March 23. Observer, THOMAS M. LOGAN, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Thermometer, mean.	.....	49.04	56.43	62.33	66.50	71.93	71.47	63.93	67.93	61.50	53.24	47.38	?
Therm'r extremes. {	.....	59	66	79	87	98	90	92	84	79	65	57	....
	.....	34	44	48	53	61	62	60	58	49	38	37	....
Rain, inches........	?	4.82	0.68	?	0.00	0.35	0.01	?	0.00	0.66	2.40	1.63	?

SAG HARBOR, NEW YORK.

Latitude, 41° N.; longitude, 72° 20′ W. Elevation above tide-water, 40 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7; earliest frost in autumn, November 15; period without frost, 221 days. Observer, EPHRAIM N. BRYAN.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	20.72	36.20	34.89	43.38	56.17	65.43	71.70	71.42	65.21	54.68	45.41	39.47	50.39
Therm'r extremes. {	44	66	58	65	82	84	90	90	83	76	70	65	....
	— 6	5	10	19	42	51	52	60	43	36	21	18	....
Rain, inches...... ..	4.36	1.33	2.75	4.97	3.05	1.94	4.44	4.17	1.65	3.80	2.70	2.05	37.21

SAYBROOK, CONNECTICUT.

Latitude, 41° 18′ N.; longitude, 72° 20′ W. Elevation above tide-water, 10 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 7; earliest frost in autumn, October 21; period without frost, 196 days. Observer, JAMES RANKIN.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	18.85	31.98	32.02	40.41	52.64	61.51	68.57	69.45	62.53	53.03	42.36	35.99	47.44
Therm'r extremes. {	40	50	48	56	74	82	84	83	79	69	62	50	....
	—12	4	9	29	41	52	54	57	40	32	15	13	....
Rain, inches........	5.14	1.45	2.49	6.55	3.87	3.53	7.37	4.93	2.26	3.88	2.42	6.08	49.97

SHAMOKIN, PENNSYLVANIA.

Latitude, 40° 45′ N.; longitude, 76° 31′ W. Elevation above tide-water, 700 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 13; earliest frost in autumn, August 25; period without frost, 103 days. Observer, P. FRIEL.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	16.80	36.43	33.49	40.43	54.52	63.41	69.69	66.78	60.11	48.51	38.33	35.44	46.70
Therm'r extremes. {	34	68	58	60	90	92	96	94	86	72	70	59	....
	—30	—10	......	12	28	38	48	39	32	22	4	12	....
Rain, inches........	2.96	1.90	2.50	6.24	10.60	9.76	6.05	4.08	1.91	2.69	2.41	5.91	57.01

SHELBURNE, VERMONT.

Latitude, 44° 23′ N.; longitude, 73° W. Elevation above tide-water, 150 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 11; earliest frost in autumn, October 22; period without frost, 163 days. Observer, GEORGE BLISS.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	7.50	26.94	26.12	39.07	53.73	62.05	70.97	65.49	57.59	44.40	36.46	27.46	43.15
Therm'r extremes.	33	54	48	64	85	78	91	83	80	64	68	48	....
	—30	—15	— 7	8	30	48	53	51	37	27	5	......	....
Rain, inches........	1.90	4.40	1.61	7.87	3.04	5.17	6.42	6.54	1.54	5.05	2.00	2.62	48.16

ST. AUGUSTINE, FLORIDA.

Latitude, 29° 48′ N.; longitude, 81° 35′ W. Elevation above tide-water, 8 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, January 23. Observer, T. B. MAURAN, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	50.76	62.39	60.72	65.01	73.60	78.53	78.99	80.50	80.76	71.20	65.74	65.33	69.46
Therm'r extremes.	69	81	79	86	85	90	92	93	93	82	83	81	....
	19	48	41	50	64	73	73	74	72	51	39	50	....
Rain, inches........	0.58	0.53	5.18	2.35	2.83	5.78	6.63	6.65	1.25	3.00	1.60	4.55	40.85

ST. LOUIS, MISSOURI.

Latitude, 28° 37′ N.; longitude, 90° 16′ W. Elevation above tide-water, 46 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 19; earliest frost in autumn, October 20; period without frost, 183 days. Observer, A. WISLIZENUS, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	19.30	42.10	39.47	44.44	61.80	72.63	79.47	76 28	71.30	54.60	39.07	40.53	53.42
Therm'r extremes.	45	74	74	77	88	92	101	98	93	81	67	59	....
	—125	5	10	20	39	52	59	59	48	30	11	24	....
Rain, inches........	0.41	7.74	1.80	1.72	4.81	3.71	2.82	4.15	3.18	3.02	3.80	1.87	39.03

SALT PONDS, FLORIDA.

Latitude, 24° 33′ N.; longitude, 81° 48′ W. Elevation above tide-water, 4 feet. Hours of observation, 7 A. M. and 2 P. M. Period without frost, 365 days. Observer, WILLIAM C. DENNIS.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	63.74	67.98	70.35	71.07	77.93	82.08	81.74	83.39	83.53	74.85	74.67	74.95	75.69
Therm'r, extremes.	78	80	80	82	86	87	88	89	89	83	85	85	....
	42	57	62	58	70	78	72	77	77	68	59	61	....
Rain, inches........	0.48	0.74	?	1.44	0.54	2.90	9.62	3.43	9.11	4.29	1.07	0.72	?

SAN FRANCISCO, CALIFORNIA.

Latitude, 37° 48′ N.; longitude, 122° 23′ W. Elevation above tide-water, 115 feet. Hours of observation, 7 A. M. and 2 P. M. Period without frost, 365 days. Observer, WILLIAM O. AYRES, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	51.59	51.69	56.19	59.62	57.16	61.12	59.92	59.80	62.33	61.59	56.37	51.77	57.43
Therm'r, extremes.	66	68	75	83	78	98	73	97	92	85	70	61	....
	36	38	47	51	51	53	53	53	54	52	46	43	....
Rain, inches	1.30	4.93	0.81	0.00	0.00	0.14	0.00	?	0.00	0.24	2.22	3.34	12.97

SAVANNAH, GEORGIA.

Latitude, 32° 05′ N.; longitude, 81° 17′ W. Elevation above tide-water, 42 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, March 3; earliest frost in autumn, September 20; period without frost, 200 days. Observer, JOHN F. POSEY, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	41.33	57.83	53.37	59.23	70.50	79.30	76.97	78.88	76.27	62.62	57.50	57.23	64.26
Therm'r, extremes.	66	79	80	80	88	97	88	96	92	80	79	78	....
	13	34	29	38	53	68	63	67	57	45	27	38	....
Rain, inches	1.85	0.95	2.80	2.66	1.25	0.85	10.27	4.74	1.08	3.12	1.03	2.91	33.51

SAVANNAH, OHIO.

Latitude, 41° 12′ N.; longitude, 82° 30′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, June 6; earliest frost in autumn, September 23; period without frost, 108 days. Observer, JOHN INGRAM, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	14.17	37.01	32.29	38.36	56.76	69.14	74.26	71.33	66.08	50.16	34.59	34.64	48.23
Therm'r, extremes.	39	67	74	70	88	97	98	98	95	77	69	58	....
	—20	0	— 4	18	32	47	54	53	37	23	—10	18	....
Rain, inches	1.73	3.40	1.23	2.76	4.34	3.69	5.63	3.63	1.80	5.46	6.60	3.75	44.00

SPRINGDALE, KENTUCKY.

Latitude, 38° 07′ N.; longitude, 85° 34′ W. Elevation above tide-water, 570 feet. Latest frost in spring, April 28; earliest frost in autumn, September 30; period without frost, 184 days. Observer, MRS. LAWRENCE YOUNG.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean	21.24	47.87	40.84	42.68	58.68	69.69	73.70	73.61	69.69	54.94	41.76	41.59	53.03
Therm'r, extremes.	43	75	80	77	93	93	96	95	93	80	73	64	....
	—24	8	11	18	46	46	47	48	32	22	10	22	....
Rain, inches	1.89	3.76	0.50	5.54	5.17	5.17	4.33	4.39	0.87	1.99	5.32	5.00	46.70

THE ROCK, GEORGIA.

Latitude, 32° 52′ N.; longitude, 84° 23′ W. Elevation above tide-water, 833 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 14 ; earliest frost in autumn, November 19 ; period without frost, 218 days. Observer, JAMES ANDERSON, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Thermometer, mean	35.56	56.57	52.03	56.51	68.17	76.24	76.86	76.76	74.19	60.83	51.48	50.78	61.41
Therm'r extremes.	62	78	79	77	90	93	91	92	93	81	80	72	....
	3	26	28	32	42	59	58	62	52	40	20	30	....
Rain, inches	2.45	0.41	2.10	3.02	5.37	0.90	5.10	4.64	0.51	0.67	5.87	5.79	36.83

TORONTO, CANADA.

Latitude, 43° 39′ N.; longitude, 79° 21′ W. Elevation above tide-water, 108 feet. Hours of observation, 6 A. M. and 2 and 10 P. M. Latest frost in spring, May 17 ; earliest frost in autumn, September 21 ; period without frost, 116 days. Observers, OPERATORS OF MAGNETIC OBSERVATORY.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	13.01	28.47	27.67	35.01	48.45	56.74	67.39	64.70	58.11	45.34	33.67	32.03	42.55
Therm'r extremes.	32	50	56	52	72	74	85	85	81	61	58	46	....
	—18	— 6	—3.7	10	28	41	52	50	37	29	— 2	5.7	....
Rain, inches	2.21	4.22	1.52	3.05	4.15	5.06	3.48	5.27	2.64	1.06	3.93	4.11	40.67

WALLINGFORD, CONNECTICUT.

Latitude, 41° 26′ N.; longitude, 72° 50′ W. Elevation above tide-water, 133 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 16 ; earliest frost in autumn, September 30 ; period without frost, 166 days. Observer, B. T. HARRISON.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	13.42	32.52	31.89	41.27	54.55	62.61	69.75	67.70	60.69	50.29	38.43	34.21	46.44
Therm'r extremes.	36.5	66	57	62	84	82	90	90	84	72	68	58	....
	—21	— 1	—0.5	15	36	49	52	52	32	27	9	—0.5	....
Rain, inches........	4.39	?	2.47	7.11	7.76	3.23	8.29	5.62	3.17	5.88	2.06	4.38	?

WESTFIELD, MASSACHUSETTS.

Latitude, 42° 06′ N.; longitude, 72° 48′ W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 30 ; earliest frost in autumn, October 1 ; period without frost, 153 days. Observer, Rev. EMERSON DAVIS, D. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	13.65	31.37	31.34	40.53	54.32	62.80	69.34	66.53	59.65	48.60	38.42	31.64	45.68
Therm'r extremes.	34	63	54	59	85	81	90	91	87	72	67	55	....
	24	0	0	14	36	48	53	52	34	25	12	— 2	....
Rain, inches........	3.63	2.48	2.47	6.26	6.91	3.24	6.69	4.12	3.53	5.35	2.07	6.58	53.33

WEST SALEM, ILLINOIS.

Latitude, 38° 30′ N.; longitude, 88° W. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 24; earliest frost in autumn, September 29; period without frost, 157 days. Observer HENRY A. FITZE.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	21.04	45.78	39.73	41.66	62.04	71.37	76.52	75.45	70.59	54.47	40.27	40.46	53.28
Therm'r extremes.	49	71	78	71	90	94	96	94	90	78	74	68	....
	—10	11	5	24	41	56	58	60	45	26	8	23	....
Rain, inches	?	4.52	1.13	1.70	4.37	6.83	3.24	5.75	1.37	1.19	5.29	3.24	?

WEYMOUTH, MASSACHUSETTS.

Latitude, 42° 10′ N.; Longitude, 71° W. Elevation above tide-water, 150 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, May 1; earliest frost in autumn, September 30; period without frost, 151 days. Observer, N. QUINCY TIRRELL, M. D.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	15.19	31.30	30.29	29.51	51.75	60.68	67.68	65.60	59.28	48.03	41.08	32.68	45.25
Therm'r extremes.	43	54	49	58	70	72	75	82	74	66	65	48	....
	—15	2	7	17	40	51	55	58	41	30	16	10	....
Rain, inches........	?	?	1.30	7.67	4.32	2.22	2.91	6.06	4.91	3.79	17.1	4.71	?

WORCESTER, MASSACHUSETTS.

Latitude, 42° 16′ N.; longitude, 71° 48′ W. Elevation above tide-water, 536 feet. Hours of observation, 7 A. M. and 2 and 9 P. M. Latest frost in spring, April 22; earliest frost in autumn, September 7; period without frost, 137 days. Observer, JOHN S. SARGENT.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept	Oct.	Nov.	Dec.	Annual.
Thermometer, mean.	16.16	32.73	33.29	41.10	55.38	62.88	71.01	67.90	60.49	49 [illegible]	41.31	33.51	47.08
Therm'r extremes.	38	65	59	60	85	80	89	90	85	[illegible]	68	54	....
	—13	— 4	5	13	39	51	51	55	37	29	15	5	....
Rain, inches........	?	2.24	2.80	8.77	?	2.53	?	?	?	?	?	6.31	?

Register of the temperature and face of the sky, for each day of the year 1857, at several points in Nova Scotia, Canada, and the United States.

[EXPLANATION.—C, denotes that the weather was cloudy; F, fair; R, rainy; S, snowy.]

Jan. 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.			Alexandria, Va.			All Saints, S. C.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	C. 27	C. 30	C. 28	C. 23	C. 27	C. 24	C. 34	C. 35	C. 32	C. 23	C. 26	C. 24	C. 27	C. 34	C. 34	C. 40	C. 43	C. 39
2	C. 26	C. 30	F. 27	F. 21	C. 24	C. 21	C. 31	C. 33	C. 32	C. 23	C. 34	C. 29	C. 32	C. 40	C. 38	C. 37	C. 44	R. 41
3	C. 27	C. 29	C. 27	C. 21	S. 27	S. 21	C. 34	S. 34	S. 34	S. 29	S. 30	C. 28	C. 36	F. 38	C. 31	R. 56	F. 52	F. 43
4	C. 28	C. 31	C. 28	S. 22	C. 25	F. 18	C. 28	C. 28	F. 24	C. 24	C. 25	C. 22	F. 27	F. 32	F. 29	F. 32	F. 45	F. 33
5	C. 23	C. 25	C. 21	C. 4	F. 3	F. —2	F. 20	C. 24	F. 17	C. 19	C. 22	C. 15	C. 27	C. 35	C. 32	F. 31	F. 45	F. 35
6	C. 14	C. 19	F. 16	F. —13	C. —8	C. —7	F. 10	F. 17	F. 14	C. 7	C. 10	C. 9	F. 24	F. 28	F. 18	C. 35	F. 48	F. 36
7	C. 16	C. 22	C 20	C. —14	C. —6	C. —6	F. 10	F. 17	F. 12	C. 12	C. 15	C. 7	F. 13	C. 26	C. 23	F. 31	F. 40	F. 31
8		C. 26	C. 23	C. —15	F. —6	F. —8	C. 6	C. 15	F. 13	C. 1	C. 7	C. 8	F. 8	F. 19	F. 12	F. 29	F. 37	F. 27
9	15	F. 18	C. 18	S. —2	S. 15	C. 15	F. 9	F. 25	F. 19	C. 10	C. 17	C. 17	F. 9	F. 29	F. 20	F. 21	F. 41	F. 36
10	F. 10	C. 24	S. 23	C. 10	C. 23	S. 11	C. 22	C. 32	S. 32	S. 20	S. 24	C. 22	C. 25	C. 35	C. 29	F. 37	R. 50	C. 47
11	S. 23	S. 27	S. 26	C. 3	C. 10	C. —1	C. 32	S. 22	S. 24	S. 17	S. 16	C. 9	C. 31	F. 34	F. 22	F. 34	F. 41	F. 30
12	F. 17	C. 22	F. 18	C. —4	F. 6	C. 16	F. 8	F. 18	F. 17	C. 10	? 14	? 9	F. 13	F. 25	F. 18	F. 22	F. 26	F. 29
13	C. 17	F. 26	F. 23	C. 19	S. 23	S. 21	F. 26	C. 38	F. 29	C. 9	F. 22	C. 21	C. 13	F. 36	F. 24	C. 33	F. 47	F. 31

Jan. 1857.	Warrington, Fla.			Austin, Tex.			Glenwood, Tenn.			Hillsboro', Ohio.			Platteville, Wis.			San Francisco, Cal.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	C. 63	C. 61	F. 55	F. 29	C. 63	C. 52	C. 25	C. 29	C. 30	? 16	F. 27	C. 26	F. 11	C. 20	S. 22	C. 48	C. 51	C. 48
2	C. 56	C. 68	F. 66	C. 57	F. 60	F. 37	C. 31	C. 36	C. 34	? 28	C. 34	C. 33	S. 24	S. 20	C. 2	C. 48	R. 49	R. 52
3	F. 47	F. 54	F. 55	F. 23	F. 42	F. 33	F. 15	F. 22	F. 18	? 22	C. 34	C. 33	F. —9	F. —6	C. —14	R. 53	R. 51	R. 47
4	F. 34	F. 57	F. 54	C. 31	C. 49	C. 46	F. 13	C. 26	C. 26	? 10	C. 18	C. 18	C. —8	C. 5	C. 0	F. 46	F. 50	R. 46
5	C. 46	C. 58	F. 58	C. 48	C. 55	C. 49	C. 28	C. 37	C. 32	? 19	C. 26	C. 24	C. —2	F. 4	F. —10	C. 46	C. 52	C. 49
6	C. 52	C. 51	C. 53	C. 32	C 32	C. 30	C. 20	C. 29	C. 26	? 17	? 22	F. 18	F. —2	F. 8	F. —4	F. 45	C. 50	C. 46
7	C. 45	C. 52	C. 48	C. 29	C. 33	C. 30	C. 23	C. 25	F. 18	? 20	F. 20	F. 12	F. —12	F. 0	F. —12	F. 40	F. 49	F. 42
8	F. 44	F. 59	F. 53	C. 27	C. 30	C. 30	C. 13	C. 23	F. 20	F. 4	F 16	F. 12	F. —14	F. 4	F. —3	F. 36	F. 45	F. 40
9	C. 45	C. 47	C. 46	C. 28	C. 34	C. 32	C. 14	C. 33	C. 31	F. 10	F. 27	F. 24	F. —8	F. 20	S. 14	F. 37	F. 46	F. 41
10	C. 55	C. 53	F. 48	C. 19	C. 33	F. 29	C. 29	C. 26	C. 22	C. 24	C. 28	? 20	C. 16	F. 21	F. 14	C. 41	C. 51	C. 46
11	F. 29	F. 45	F. 48	F. 21	F. 40	F 26	C. 23	C. 29	F. 23	C. 20	C. 18	F. 9	F. 9	F. 16	F 4	C. 47	C. 53	C. 50
12	F. 29	F. 46	F. 46	F. 16	F. 48	F. 34	F. 14	C. 32	F. 24	F. 1	F. 21	? [illegible]	F. 0	F. 16	F. —4	F. 46	C. 58	C. 55
13	F. 28	F. 46	F. 48	F. 28	F. 62	F. 47	F. 19	F. 35	F. 28	C. 15	F. 29	F. 19	F. —8	F. 16	C. 14	C. 49	F 60	F. 55

14	C. C. C. 23 34 29	C. C. C. 19 19 10	F. F. C. 22 32 26	C. C. S. 21 26 21	F. C. C. 14 35 28	F. F. F. 27 46 42	F. F. F. 35 62 53	F. F. F. 43 72 45	C. C. C. 27 39 27	C. C. C. 14 23 21	C. F. F. 10 16 —11	C. C. C. 53 55 55
15	C. R. R. 25 31 24	C. C. F. 3 2 —5	C. C. F. 26 26 14	C. C. ? 10 8 7	C. F. F. 26 23 16	F. F. F. 38 49 34	F. F. F. 42 59 53	C. C. C. 32 50 49	F. F. F. 18 24 17	C. F. F. 15 15 5	F. F. C. —11 10 2	C. R. R. 54 57 53
16	F. F. F. 5 13 14	S. C. C. —3 17 13	F. F. C. 5 18 25	F. C. S. 0 17 20	F. F. C. 5 21 26	F. C. C. 24 39 31	C. C. C. 40 56 54	C. F. F. 47 70 57	C. C. C. 24 37 33	C. C. C. 9 25 25	S. C. F. 10 10 —2	R. R. R. 55 56 55
17	C. F. C. 24 28 26	C. C. F. 13 7 —14	C. C. C. 29 33 27	C. ? C. 20 9 1	C. C. C. 29 37 31	C. F. S. 37 56 50	F. F. F. 54 60 59	C. C. F. 34 34 21	C. C. C. 29 21 11	C. C. C. 24 22 14	C. F. F. —16 —2 —22	R. R. F. 51 54 50
18	C. F. C. —10 —2 —2	F. F. C. —20 —10 —15	S. S. S. 8 16 20	C. C. C. —12 —1 1	R. R. R. 10 3 5	S. S. C. 56 28 16	F. F. F. 27 38 29	F. F. F. 12 30 22	C. F. F. 0 7 4	C. F. F. 3 5 0	F. F. F. —29 4 —18	F. F. F. 49 53 52
19	S. C. F. 12 33 42	C. S. C. —9 11 9	C. S. S. 33 39 26	C. F. C. 5 12 18	R. C. F. 8 16 14	F. F. F. 16 24 23	F. F. F. 14 49 40	C. C. C. 20 52 46	F. F. F. 8 13 10	F. F. F. 6 9 3	F. F. C. —18 8 10	F. F. F. 56 61 53
20	C. C. C. 35 30 20	S. S. S. —3 9 7	F. F. F. 12 25 23	C. S. C. 13 20 22	F. F. C. 5 24 26	F. C. C. 18 37 34	F. F. F. 32 45 50	F. F. F. 43 62 48	C. C. C. 17 28 31	C. C. C. 10 23 24	C. C. F. 16 14 —12	F. F. F. 54 57 54
21	F. C. S. 11 34 36	C. S. F. 9 26 18	R. F. C. 35 39 35	C. C. ? 23 17 11	F. C. C. 28 39 22	R. R. C. 34 40 38	C. F. F. 46 57 59	F. F. F. 34 66 48	C. C. F. 14 12 6	C. F. F. 7 8 —1	F. F. F. —18 —12 —24	F. F. F. 52 60 55
22	R. R. C. 42 46 34	C. F. F. 2 —4 —19	S. S. F. 26 24 4	C. C. C. 4 —5 —6	F. F. F. 8 9 4	F. F. F. 21 29 23	F. F. F. 26 39 41	F. F. F. 29 62 50	C. C. C. 6 8 6	C. C. F. 10 1 —6	C. F. F. —23 —10 —21	F. F. F. 49 61 53
23	F. C. C. 14 10 —7	C. C. F. —27 —18 —21	F. F. F. —7 4 3	C. F. ? —6 —1 —3	F. F. F. —2 11 1	C. C. C. 15 23 24	F. F. F. 31 45 48	C. C. C. 49 52 43	C. C. C. 5 2 11	F. F. F. 11 6 2	F. F. C. —24 —2 —6	F. F. F. 51 58 48
24	F. F. F. —9 4 8	F. C. C. —23 0 5	F. S. C. 0 18 22	C. C. ? 0 12 8	F. C. C. —6 21 17	C. C. F. 22 34 29	C. C. F. 38 54 53	C. C. C. 38 60 52	C. C. C. 15 28 26	C. C. C. 2 16 16	F. F. F. —12 —8 —14	F. F. F. 50 55 51
25	R. F. C. 19 26 14	FOG. F. F. —10 6 1	F. F. F. 10 22 13	C. C. C. 4 12 6	F. F. F. 3 27 16	C. F. F. 33 45 37	C. F. F. 41 64 63	C. C. F. 52 67 59	C. C. C. 21 27 26	F. F. F. 8 15 10	C. C. C. —20 5 —6	C. C. C. 50 53 49
26	C. F. F. 8 9 5	F. C. C. —10 9 12	F. F. F. 9 24 19	C. C. S. —3 22 27	F. C. C. —1 25 27	F. F. F. 32 42 32	F. F. C. 49 66 57	C. C. F. 63 70 62	C. C. C. 33 48 48	C. C. C. 12 33 40	C. C. C. 14 30 16	C. C. F. 49 55 54
27	C. C. S. 21 34 39	S. S. C. 22 31 25	C. C. R. 30 38 38	C. C. ? 36 31 25	F. R. C. 32 38 37	F. C. F. 29 55 40	C. C. C. 56 61 56	C. C. C. 58 74 58	C. C. C. 49 42 35	C. C. C. 41 36 30	F. F. C. 0 24 4	C. C. C. 50 54 55
28	S. S. S. 38 39 32	HAZY. C. F. 16 19 10	R. C. R. 36 36 35	C. C. ? 22 28 21	C. R. C. 36 32 32	F. C. F. 39 61 43	C. F. F. 55 72 63	C. C. C. 46 58 53	C. C. C. 34 38 33	C. C. F. 26 32 32	F. F. F. 8 24 6	C. F. F. 51 60 56
29	S. S. S. 30 36 36	C. C. F. 10 25 7	R. R. R. 35 37 34	C. F. ? 24 29 21	C. C. C. 33 28 37	R. C. C. 48 48 46	C. C. C. 56 55 59	C. C. C. 46 48 48	F. C. F. 28 43 37	F. F. F. 21 34 29	C. F. C. 12 28 16	F. F. F. 54 66 60
30	C. F. F. 26 28 19	F. F. F. 6 1 —4	F. F. F. 30 36 30	C. C. ? 22 25 21	F. C. R. 22 38 34	C. C. R. 39 41 44	C. C. C. 61 57 58	F. F. ? 40 61 47	C. C. C. 33 36 35	F. C. C. 24 37 30	C. C. S. 20 36 18	F. F. F. 59 63 60
31	F. F. S. 7 16 19	C. S. S. —2 10 10	C. R. R. 32 36 41	S. C. C. 26 35 36	R. C. C. 35 38 37	C. C. F. 49 58 51	C. F. F. 49 63 54	? ? ? 39 66 50	C. C. C. 37 42 37	C. C. F. 31 34 23	F. F. F. —12 —4 —12	F. F. F. 51 58 48

Register of the temperature and face of the sky, &c.—Continued.

Feb. 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M
1	S. 42	S. 47	S. 40	C. 13	C. 19	C. 14	C. 36	C. 36	C. 33	C. 14	F. 11	C. 11
2	S. 34	C. 30	C. 22	C. 9	C. 14	F. 2	C. 30	F. 30	F. 30	C. 9	C. 14	C. 13
3	C. 16	F. 12	F. 6	C. —1	R. 0	R. 5	F. 12	F. 24	F. 22	C. 9	C. 23	C. 27
4	F. 4	C. 30	C. 24	R. 18	C. 20	FOG 15	F. 32	F. 38	C. 38	R. 39	C. 35	C. 32
5	F. 14	F. 22	C. 19	C. 10	S. 13	S. 33	C. 36	C. 39	C. 34	R. 33	C. 44	F 45
6	C. 33	C. 47	C. 41	S. 38	C. 45	S. 38	C. 41	C. 48	C. 44	C. 43	C. 54	C. 49
7	C. 40	F. 51	F. 52	C. 41	C. 46	C. 42	C. 48	C. 52	C. 45	C. 50	C. 58	C. 55
8	F. 52	S. 62	S. 56	C. 46	S. 45	C. 35	C. 48	C. 51	C. 46	R. 50	C. 33	C. 25
9	S. 53	S. 35	C. 20	F. 13	F. 14	F. 11	C. 36	C. 28	? 28	C. 19	F. 25	24
10	F. 13	F. 21	C. 20	F. 16	C. 11	F. —6	F. 28	F. 38	C. 26	S. 25	C. 11	? 63
11	F. —1	F. —2	C. —5	F. —11	C. —4	C. —8	F. 7	F. 18	F. 14	C. 5	C. 11	F. 9
12	F. —9	F. 1	F. —2	C. —13	C. 8	C. 14	F. 12	F. 20	C. 24	F. 11	C. 30	C. 30
13	C. 13	C. 34	C. 39	C. 24	C. 34	C. 35	C. 34	C. 44	C. 38	C. 37	F. 46	? 36
14	C. 37	C. 32	C. 21	C. 15	C. 17	C. 17	F. 34	F. 43	F. 34	F. 30	C. 46	C. 47

Feb. 1857.	Alexandria, Va.			All Saints, S.C.			Warrington, Fla.			Austin, Tex.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	C. 33	F. 40	F. 32	F. 38	C. 54	F. 42	F. 49	F. 62	F. 59	F. 43	F. 76	F. 63
2	F. 25	F. 28	F. 21	C. 42	F. 49	F. 37	F. 51	F. 62	C. 55	C. 63	F. 67	C. 63
3	F. 11	F. 31	F. 28	F. 36	F. 51	F. 44	C. 56	C. 64	F. 63	C. 61	F. 73	C. 63
4	F. 32	F. 52	F. 42	F. 41	F. 65	F. 51	C. 57	F. 65	F. 66	F. 61	F. 75	C. 65
5	C. 36	F. 59	C. 50	F. 44	F. 65	F. 59	F. 61	C. 63	C. 61	C. 61	F. 71	C. 63
6	F. 46	C. 62	F. 52	C. 57	C. 64	R. 59	F. 66	C. 64	C. 63	C. 63	C. 75	C. 65
7	C. 39	C. 63	C. 54	C. 56	R. 64	F. 57	C. 65	F. 67	C. 65	C. 53	F. 56	F. 40
8	C. 56	F. 64	C. 39	C. 55	F. 69	C. 63	C. 53	F. 56	F. 51	F. 27	F. 48	F. 38
9	F. 27	F. 32	F. 28	C. 46	F. 50	F. 39	F. 36	F. 52	F. 54	F. 26	C. 55	F. 43
10	F. 22	F. 35	F. 21	F. 31	F. 49	F. 34	F. 38	F. 54	F. 56	F. 31	F. 56	F. 41
11	F. 12	F. 27	F. 15	F. 31	F. 42	F. 37	F. 39	F. 56	F. 66	F. 32	C. 64	C. 58
12	F. 19	C. 37	C. 34	F. 31	F. 52	C. 47	C. 51	C. 63	C. 62	C. 58	C. 70	C. 63
13	C. 36	C. 45	C. 38	C. 48	F. 63	F. 51	F. 52	C. 65	F. 64	C. 63	C. 71	F. 63
14	F. 30	F. 54	F. 47	F. 46	F. 63	F. 86	F. 55	C. 72	C. 67	C. 63	C. 71	C. 64

Feb. 1857.	Glenwood, Tenn.			Hillsboro', Ohio.			Platteville, Wis.			San Francisco, Cal.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	R. 28	C. 35	C. 33	C. 10	C. 22	F. 17	C. —12	C. 10	F. —4	F. 59	F. 68	F. 56
2	C. 28	F. 40	F. 34	F. 7	F. 19	F. 14	C. —2	C. 18	C. 10	C. 54	C. 55	F. 49
3	C. 35	F. 67	F. 60	C. 20	C. 43	C. 47	F. 16	C. 38	C. 32	C. 44	C. 52	F. 44
4	C. 58	C. 66	C. 61	C. 49	C. 51	C. 51	C. 24	F. 36	F. 28	C. 52	C. 53	C. 50
5	C. 58	C. 69	F. 58	C. 52	C. 61	F. 53	C. 32	C. 32	C. 17	R. 49	F. 51	F. 44
6	C. 56	C. 69	C. 67	C. 51	F. 64	F. 55	C. 18	C. 35	C. 32	F. 41	C. 49	F. 42
7	C. 63	R. 66	R. 51	C. 54	F. 64	C. 61	S. 40	S. 28	C. 4	F. 38	F. 51	F. 44
8	C. 24	F. 30	F. 28	C. 28	C. 24	F. 19	F. 4	F. 18	C. 7	C. 43	F. 49	F. 41
9	F. 22	F. 37	F. 30	F. 9	F. 26	F. 22	C. 8	C. 30	F. —4	F. 41	F. 55	F. 47
10	F. 30	F. 27	F. 20	F. 20	F. 16	F. 10	F. —12	F. —8	F. —12	F. 45	F. 56	C. 53
11	F. 16	F. 39	C. 37	F. 5	F. 23	F. 19	F. —10	F. 14	C. 12	C. 53	C. 56	C. 53
12	C. 39	C. 48	C. 49	C. 24	F. 42	F. 41	C. 25	F. 42	C. 26	C. 53	R. 56	R. 56
13	R. 46	C. 52	C. 52	C. 41	C. 45	C. 42	F. 8	F. 40	F. 30	R. 54	C. 57	C. 57
14	C. 50	C. 64	F. 57	C. 41	C. 54	F. 52	R. 40	R. 44	C. 32	C. 54	R. 57	C. 55

15	C. R. R. 33 40 39	R. R. R. 36 43 39	C. F. F. 44 44 38	C. C. C. 50 54 53	C. F. F. 46 65 56	F. R. R. 54 66 62	F. C. C. 62 69 67	C. C. F. 62 78 63	C. C. R. 58 66 57	F. F. C. 51 63 58	C. C. C. 32 42 35	R. R. R. 55 56 47
16	R. R. R. 36 41 40	R. C. R. 35 35 33	C. C. C. 43 51 44	C. C. C. 48 52 51	C. C. F. 50 67 60	C. C. C. 60 64 60	C. F. C. 61 71 67	C. F. F. 63 76 64	C. C. F. 54 69 57	C. F. F. 52 61 53	C. C. C. 30 42 46	R. R. R. 48 52 48
17	C. F. F. 48 52 36	R. R. R. 35 44 46	C. C. C. 44 52 44	F. F. F. 46 63 33	C. C. F. 56 70.5 57	C. F. F. 60 69 58	C. C. F. 57 66 65	C. C. C. 63 71 69	F. C. F. 55 73 64	F. F. F. 50 67 60	C. C. C. 42 40 34	F. F. F. 45 56 57
18	F. F. F. 52 56 38	C. S. S. 46 34 28	C. C. ? 41 44 39	C. C. C. 49 44 33	C. F. F. 48 68 61	F. F. 51 72 61	C. F. F. 63 69 65	C. C. C. 67 71 68	C. F. C. 56 77 65	C. C. C. 55 66 60	C. C. S. 34 40 29	F. C. R. 46 58 50
19	S. S. C. 28 26 18	S. C. C. 17 20 16	C. C. C. 44 38 34	C. C. C 28 30 28	R. C. C. 52 75 60	F. F. F. 57 74 63	C. C. F. 64 65 66	C. C. F. 47 48 46	C. C. F. 62 68 57	C. C. C. 52 54 41	C. C. F. 24 40 23	C. C. F. 48 55 50
20	C. F. F. 4 11 8	F. C. S. 67 17 18	C. C. C. 34 34 35	C. R. R. 29 36 37	C. C. C. 43 42 40	C. F. F. 59 71 63	F. F. F. 72 75 69	F. F. F. 39 61 53	C. C. C. 56 74 46	C. C. F. 39 53 53	C. C. F. 22 30 22	F. F. F. 50 55 50
21	C. C. C. 15 36 21	S. C. C. 21 31 26	C. C. F. 44 43 36	C. C. C. 32 33 35	C. F. F. 45 59 45	F. F. C. 60 76 67	C. C. F. 68 75 58	F. C. F. 40 67 55	C. C. C. 38 40 40	C. C. C. 36 36 35	C. F. C. 24 38 28	F. F. F. 48 59 54
22	F. F. F. 15 32 28	C. C. C. 29 38 33	F. F. F. 34 40 32	C. C. C. 34 37 35	C. F. F. 35 49 45	C. C. F. 61 60 52	C. F. F. 63 70 69	C. C. C. 53 60 60	C. F. F. 38 47 41	C. C. F. 33 37 32	C. C. F. 31 37 34	F. F. F. 53 64 51
23	C. C. F. 31 37 34	C. C. C. 32 40 37	F. F. C. 34 43 38	R. C. ? 36 42 42	F. F. F. 32 57 48	? F. F. 48 60 51	F. F. F. 64 69 66	C. C. C. 61 71 65	F. F. F. 32 62 52	F. F. F. 34 55 46	F. F. C. 32 47 43	C. C. C. 49 58 50
24	F. F. C. 29 42 39	C. R. R. 35 46 44	F. F. F. 40 49 42	C. F. F. 44 63 57	F. C. C. 35 67 62	F. F. C. 49 71 65	C. C. C. 67 71 69	C. F. F. 57 75 58	C. C. C. 52 66 62	F. C. C. 43 63 56	C. C. F. 42 37 25	R. R. R. 50 55 54
25	C. F. F. 43 55 44	F. C. F. 44 45 33	C. C. F. 43 46 41	F. C. ? 45 44 35	C. C. C. 63 69 57	F. C. F. 61 74 66	F. F. F. 71 74 69	C. F. F. 58 75 61	C. F. F. 62 72 61	C. C. C. 45 52 43	C. C. F. 22 36 21	R. R. R. 48 49 49
26	F. F. F. 32 25 13	C. F. F. 13 15 7	F. C. F. 38 35 28	F. C. F. 36 25 23	F. F. F. 35 50 41	F. F. F. 60 67 55	C. F. C. 66 73 68	C. C. C. 65 75 66	F. F. F. 45 64 54	F. F. F. 31 43 37	C. C. C. 22 38 30	R. R. R. 50 53 52
27	F. F. F. —5 4 10	F. F. C. —1 10 13	C. C. F. 21 27 27	F. C. S. 22 31 21	C. C. C. 38 47 42	F. F. F. 49 71 64	C. C. C. 64 72 66	C. C. F. 67 78 68	F. F. C. 45 80 72	C. F. C. 34 55 50	C. C. F. 29 36 12	C. R. C. 53 55 56
28	F. F. C. 7 33 20	S. C. C. 6 22 17	C. F. F. 30 38 30	F. F. S. 21 32 25	F. F. F. 39 53 44	C. C. C. 64 74 62	C. F. F. 67 71 68	C. C. F. 57 70 58	C. F. F. 45 54 45	F. F. F. 32 44 36	F. F. F. 6 37 24	F. F. C. 55 64 57

Register of the temperature and face of the sky, &c.—Continued.

Mar. 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.			Alexandria, Va.			All Saints, S. C.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	C. 18	F. 26	F. 17	C. 3	C. 18	F. 10	C. 34	C. 35	C. 32	C. 22	S. 27	C. 20	F. 32	F. 53	C. 38	F. 51	F. 60	F. 57
2	C. 18	S. 21	S. 18	C. 3	F. 11	F. 7	C. 32	C. 26	C. 24	C. 10	C. 15	C. 9	F. 25	C. 25	F. 16	F. 34	F. 37	F. 32
3	S. 19	S. 21	F. 21	F. —3	F. 13	C. 18	F. 17	F. 27	F. 22	F. 45	F. 23	C. 26	F. 12	F. 33	F. 31	F. 24	C. 37	F. 35
4	F. 12	F. 37	F. 27	S. 19	C. 31	C. 24	F. 26	F. 37	F. 29	C. 25	C. 32	F. 27	F. 22	C. 45	F. 34	C. 37	F. 54	F. 42
5	F. 21	F. 36	C. 32	S. 11	C. 36	C. 34	F. 31	C. 40	F. 36	C. 33	S. 36	S. 35	C. 31	C. 42	C. 39	C. 51	C. 65	R. 60
6	C. 34	R. 44	C. 44	S. 30	C. 26	C. 11	C. 43	C. 41	C. 32	C. 24	C. 25	C. 20	C. 35	C. 37	F. 32	F. 52	F. 57	F. 47
7	F. 25	C. 26	C. 19	C. 3	C. 11	F. 6	F. 30	F. 33	F. 23	C. 12	F. 17	F. 13	C. 28	F. 30	? 24	F. 32	C. 50	C. 43
8	F. 10	F. 16	F. 12	F. 0	F. 12	F. 7	F. 20	F. 30	F. 24	C. 11	F. 21	F. 19	F. 19	C. 35	F. 28	C. 36	R. 38	C. 39
9	F. 5	F. 27	C. 25	C. 6	C. 27	C. 16	F. 24	C. 35	F. 36	S. 27	C. 34	C. 24	C. 27	S. 35	F. 33	C. 35	F. 52	C. 53
10	C. 34	C. 33	C. 25	F. 10	F. 10	F. 7	F. 31	F. 31	F. 25	C. 10	F. 19	F. 17	F. 23	F. 35	F. 31	F. 34	F. 45	C. 47
11	F. 9	F. 19	C. 19	C. —0	F. 22	F. 11	F. 31	C. 36	C. 33	C. 19	S. 33	F. 28	C. 30	C. 41	S. 35	R. 47	C. 54	C. 55
12	C. 18	F. 32	C. 26	F. 14	C. 16	F. 17	C. 35	F. 31	F. 22	F. 13	C. 23	? 18	C. 25	F. 34	F. 31	R. 42	C. 44	F. 41
13	C. 12	F. 16	F. 12	F. 15	C. 31	F. 18	F. 22	F. 32	C. 26	F. 15	C. 37	F. 32	C. 25	C. 40	S. 34	R. 39	R. 40	R. 43
14	C. 24	C. 39	F. 28	C. 23	C. 39	F. 24	C. 32	C. 38	F. 32	F. 30	C. 40	F. 30	S. 30	F. 44	F. 39	C. 36	C. 45	C. 45

Mar. 1857.	Warringron, Fla.			Austin, Tex.			Glenwood. Tenn.			Hillsboro', Ohio.			Platteville. Wis.			San Francisco, Cal.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	C. 63	F. 70	F. 71	C. 53	C. 70	F. 58	F. 36	F. 51	F. 30	F. 31	C. 36	F. 18	F. 18	F. 18	F. 8	C. 55	F. 62	F. 55
2	F. 54	F. 54	F. 49	C. 42	C. 48	C. 42	F. 19	F. 31	F. 26	F. 5	F. 16	F. 14	F. 0	F. 28	F. 21	C. 55	F. 66	F. 56
3	C. 46	C. 62	C. 60	C. 46	C. 68	F. 60	C. 27	R. 37	C. 33	F. 14	C. 34	C. 31	C. 24	F. 35	F. 24	F. 51	F. 65	F. 54
4	C. 57	F. 65	F. 63	C. 54	C. 72	C. 64	F. 30	C. 51	R. 43	C. 30	F. 40	C. 40	C. 24	S. 28	F. 22	F. 53	F. 56	C. 52
5	C. 64	R. 68	C. 66	C. 58	F. 68	C. 50	C. 42	C. 46	C. 33	C. 38	C. 43	C. 30	F. 12	F. 23	F. 4	C. 53	F. 61	F. 51
6	F. 51	F. 57	F. 52	C. 36	C. 49	C. 40	F. 23	C. 36	F. 22	C. 20	C. 29	F. 16	C. 12	F. 24	F. 1	F. 49	F. 60	F. 51
7	R. 41	C. 46	C. 44	C. 39	C. 49	C. 49	F. 17	F. 28	C. 27	F. 13	F. 21	F. 16	F. —11	F. 16	F. —3	F. 49	C. 66	C. 51
8	F. 51	F. 52	F. 51	C. 46	F. 63	C. 56	F. 26	F. 44	C. 43	F. 12	F. 32	C. 31	C. 6	C. 26	C. 18	C. 53	C. 62	F. 52
9	F. 59	F. 70	C. 53	C. 45	C. 46	C. 43	C. 35	F. 32	F. 24	R. 32	C. 24	F. 16	F. 4	F. 14	F. —3	C. 55	F. 60	F. 53
10	R. 47	R. 57	C. 47	C. 43	C. 60	C. 50	F. 19	C. 40	C. 36	F. 3	F. 24	F. 21	C. 1	C. 24	C. 12	F. 50	C. 66	F. 58
11	C. 63	R. 58	R. 59	C. 44	C. 48	C. 38	C. 31	F. 35	F. 25	F. 18	F. 29	F. 20	F. —2	F. 16	F. —2	C. 58	F. 74	F. 57
12	C. 41	F. 53	C. 51	F. 27	C. 46	F. 34	F. 18	F. 32	F. 26	F. 10	F. 26	F. 21	F. —10	F. 28	C. 12	F. 57	F. 74	F. 55
13	R. 43	R. 48	R. 44	F. 26	F. 62	F. 50	C. 24	C. 35	F. 31	F. 18	C. 37	C. 32	C. 22	F. 40	C. 32	C. 58	F. 75	F. 55
14	C. 43	F. 53	F. 50	C. 46	C. 50	F. 50	C. 31	C. 50	F. 39	F. 28	F. 44	F. 35	C. 26	F. 41	F. 22	F. 51	C. 71	F. 51

15	F. F. F. 22 24 22	F. F. F. 14 33 25	F. F. F. 38 40 33	F. F. F. 26 41 31	F. F. C. 28 40 45	F. F. F. 37 52 44	F. C. F. 67 65 58	C. F. F. 42 64 44	F. F. C. 31 44 38	F. F. F. 32 48 39	F. F. C. 14 40 23	C. C. C. 52 62 55
16	F. C. C. 19 43 34	C. C. R. 30 34 32	C. F. C. 37 45 42	F. C. ? 27 43 30	C. C. F. 37 57 46	C. ? F. 40 58 51	F. F. F. 56 60 53	F. F. F. 44 73 58	C. F. F. 32 59 34	C. C. F. 36 46 37	C. C. C. 30 42 32	C. F. F. 54 65 54
17	F. C. C. 35 42 34	F. C. F. 28 37 30	F. F. F. 36 44 36	C. C. ? 33 44 36	F. F. F. 33 62 48	F. F. F. 38 60 47	F. F. F. 54 62 60	C. F. F. 55 81 66	C. C. C. 40 61 58	C. C. C. 35 53 48	C. C. S. 28 47 33	F. F. F. 54 66 53
18	F. F. C. 28 37 35	C. R.S. R.S. 16 25 40	F. C. F. 38 44 40	C. C. C. 39 55 46	C. F. F. 46 65 55	F. C. ? 42 67 59	F. F. F. 68 68 63	F. F. F. 57 74 54	C. C. C. 55 46 37	C. C. C. 50 43 34	S. S. C. 32 35 38	C. F. C. 56 64 57
19	C. C. R. 39 51 39	R.S. R.S. R.S 35 29 26	R. R. F. 44 47 40	S. C. C. 35 31 30	R. R. C. 52 42 40	F. F. F. 51 56 48	F. F. F. 52 73 63	F. F. F. 58 81 63	C. F. F. 35 49 40	C. C. F. 31 35 31	C. C. F. 23 43 29	F. F. F. 53 56 48
20	F. C. R. 38 43 27	C. C. F. 26 32 27	C. C. F. 36 40 38	C. ? C. 30 38 33	F. F. F. 39 55 45	F. F. F. 39 62 53	F. F. F. 54 69 65	C. F. F. 61 80 71	F. F. C. 39 75 71	F. F. C. 27 50 48	C. C. F. 30 48 34	F. F. F. 47 57 52
21	R. R. R. 25 27 24	C. S. S. 20 28 27	C. C. F. 35 40 34	C. C. ? 38 42 39	C. F. F. 46 61 52	F. F. F. 53 73 58	F. F. F. 60 72 67	C. C. C. 70 80 70	F. F. F. 41 61 49	F. F. F. 36 53 43	F. F. C. 29 52 40	C. F. F. 53 56 47
22	R. C. F. 24 33 22	S. S. S. 27 35 27	C. C. C. 35 36 33	? C. C. 36 46 40	F. F. F. 38 61 51	F. F. F. 52 62 55	F. F. F. 68 74 71	C. C. F. 66 81 66	F. F. F. 42 75 69	F. C. C. 38 63 56	R. R. R. 40 42 43	F. F. F. 55 61 50
23	F. F. F. 15 40 31	C. R. C. 27 35 36	C. C. C. 33 39 35	C. F. ? 43 58 46	C. C. F. 46 60 61	F. F. F. 58 70 62	F. F. F. 63 75 71	C. F. F. 61 81 64	F C. F. 62 80 70	R. C. C. 59 73 55	R. R. R. 37 46 38	C. F. F. 51 59 53
24	S. C. C. 32 39 33	C. C. C. 27 47 38	C. C. C. 42 40 38	R. R. C. 42 43 38	C. C. C. 47 71 66	F. F. F. 57 75 65	C. F. F. 65 78 69	C. F. F. 61 76 68	C. C. C. 68 71 56	C. C. F. 52 58 46	C. F. F. 36 44 34	F. F. F. 55 58 51
25	C. C. C. 34 35 31	R. R. C. 36 39 34	C. F. C. 41 50 38	R. R. R. 33 33 29	F. F. C. 56 50 41	F. F. F. 60 75 64	F. F. F. 73 79 71	C. F. F. 58 79 68	F. F. F. 46 60 49	F. C. F. 36 43 37	F. F. F. 28 48 35	F. F. F. 48 59 48
26	C. C. C. 31 41 36	C. C. C 35 41 36	F. C. C. 36 46 40	C. F. ? 29 35 34	F. C. F. 38 43 39	F. F. F. 45 61 48	C. C. C. 63 78 69	C. F. F. 64 82 70	C. C. R. 37 56 46	F. F. F. 27 43 38	C. C. C. 31 50 39	F. C. F. 48 65 54
27	C. C. F. 36 43 36	C. C. C. 38 41 39	F. F. F. 37 46 37	C. C. C. 33 40 37	F. F. F. 36 52 45	F. F. F. 41 60 48	C. C. F. 68 74 71	C. F. F. 65 82 72	C. F. C. 45 57 50	C. F. F. 33 50 42	C. C. F. 34 54 38	C. F. F. 53 62 53
28	F. F. F. 34 40 37	C. C. C. 35 46 39	C. C. C. 39 51 41	C. C. C. 35 42 39	F. C. F. 35 46 45	C. F. F. 44 63 47	C. C. F. 66 73 68	C. F. F. 63 82 72	F. F. F. 43 63 49	F. F. F. 36 52 44	C. F. F. 28 56 40	C. C. F. 54 51 50
29	C. C. F. 36 43 35	C. F. C. 39 46 41	F. F. C. 41 50 40	C. C. C. 36 43 40	C. C. C. 37 48 43	F. F. F. 44 63 51	R. C. C. 66 75 71	C. C. F. 62 84 69	C. F. F. 44 60 52	F. F. F. 35 49 42	F. F. F. 34 60 41	F. F. F. 52 62 52
30	C. F. F. 36 41 34	F. F. F. 38 49 45	C. C. C. 40 48 40	? ? ? 35 49 40	C. C. C. 40 56 49	F. F. F. 43 57 42	C. F. F. 61 80 69	C. C. C. 66 83 70	C. C. C. 41 59 52	F. F. F. 30 47 42	F. C. C. 36 62 46	C. F. F. 53 64 55
31	C. F. F. 36 47 36	C. C. C. 47 48 40	F. F. F. 41 53 40	? ? C. 35 54 45	F. F. C. 39 57 51	F. F. F. 40 60 51	F F. F. 64 71 65	C. C. C. 66 81 70	C. C. C. 47 54 65	F. C. C. 33 51 44	C. C. C. 42 48 49	C. C. F. 55 62 56

Register of the temperature and face of the sky, &c.—Continued.

Apr. 1857.	Wolfville, Nova Scotia. 7 A.M.	2 P.M.	9 P.M.	Montreal, Canada. 7 A.M.	2 P.M.	9 P.M.	Nantucket, Mass. 7 A.M.	2 P.M.	9 P.M.	Rochester, N. Y. 7 A.M.	2 P.M.	9 P.M.
1	F. 33	F. 40	S. 45	C. 44	C. 26	C. 15	F. 40	C. 48	C. 41	C. 24	S. 29	C. 22
2	S. 28	C. 23	F. 21	C. 9	F. 25	F. 21	S. 25	C. 29	C. 26	C. 13	C. 30	? 25
3	F. 16	F. 27	F. 24	F. 25	C. 35	C. 28	F. 28	F. 37	F. 30	C. 24	C. 42	? 40
4	F. 27	F. 42	F. 35	C. 32	C. 50	C. 37	C. 36	F. 47	F. 40	C. 41	C. 58	? 48
5	F. 35	F. 47	F. 40	C. 32	C. 53	S. 49	C. 46	C. 50	F. 46	C. 50	R. 56	R. 57
6	F. 45	F. 64	F. 50	C. 52	S. 50	S. 32	R. 49	C. 54	C. 51	R. 38	R. 30	R. 24
7	C. 50	C. 53	F. 34	C. 25	C. 31	F. 27	C. 37	C. 41	F. 35	S. 21	C. 31	C. 28
8	F. 34	F. 43	F. 33	C. 29	C. 40	C. 38	F. 39	F. 44	F. 36	C. 37	C. 41	C. 41
9	F. 34	C. 45	C. 48	R. 37	C. 43	C. 39	C. 38	C. 44	R. 40	C. 36	C. 42	C. 39
10	C. 45	F. 65	C. 50	C. 36	C. 43	R. 37	C. 42	R. 49	R. ?	C. 34	C. 42	C. 40
11	C. 42	C. 57	C. 45	C. 34	C. 43	R. 39	C. 44	F. 51	F. 41	C. 38	R. 40	C. 38
12	C. 44	F. 51	F. 40	C. 36	C. 46	F. 40	F. 48	C. 52	C. 47	C. 37	C. 43	F. 33
13	F. 37	F. 60	F. 43	F. 43	F. 49	C. 43	R. 47	C. 49	C. 40	F. 34	F. 47	? 36
14	C. 40	C. 57	C. 51	C. 37	R. 36	R. 38	C. 43	C. 50	F. 45	C. 39	C. 44	C. 36

Apr. 1857.	Alexandria, Va. 7 A.M.	2 P.M.	9 P.M.	All Saints, S. C. 7 A.M.	2 P.M.	9 P.M.	Warrington, Fla. 7 A.M.	2 P.M.	9 P.M.	Austin, Tex. 7 A.M.	2 P.M.	9 P.M.
1	R. 48	C. 51	C. 47	C. 51	C. 67	C. 63	F. 58	C. 72	C. 66	C. 58	C. 66	F. 53
2	F. 28	F. 39	F. 34	R. 48	R. 43	R. 41	C. 60	C. 56	C. 50	F. 49	F. 66	F. 57
3	F. 28	F. 46	F. 39	F. 36	C. 55	C. 51	C. 46	C. 68	? 52	C. 54	F. 76	F. 62
4	F. 42	F. 62	F. 54	F. 49	F. 65	F. 57	C. 52	F. 72	F. 68	C. 61	C. 72	C. 64
5	C. 53	C. 70	C. 61	F. 57	C. 67	C. 63	C. 62	C. 70	C. 68	C. 52	C. 52	F. 40
6	C. 63	R. 36	C. 31	C. 67	R. 56	F. 44	R. 53	F. 58	F. 48	F. 24	F. 68	F. 52
7	F. 29	F. 45	F. 40	F. 35	F. 48	F. 41	F. 38	F. 60	F. 52	F. 49	F. 74	F. 60
8	F. 38	F. 55	F. 46	F. 40	F. ?	F. 51	F. 46	F. 70	F. 62	C. 49	C. 62	C. 52
9	F. 45	F. 68	C. 54	F. 44	F. 66	C. 59	F. 54	C. 71	C. 58	C. 47	F. 70	F. 48
10	C. 46	C. 53	C. 50	C. 52	F. 66	F. 56	F. 47	C. 68	F. 56	F. 50	F. 76	F. 56
11	F. 45	C. 63	F. 60	F. 48	F. 66	F. 58	F. 46	F. 74	F. 63	F. 49	C. 64	C. 30
12	C. 45	?. 47	C. 45	F. 54	F. 66	C. 60	F. 54	C. 68	R. 53	F. 33	F. 65	F. 46
13	C. 43	R. 41	R. 38	R. 52	C. 51	F. 47	C. 50	F. 67	F. 56	F. 47	F. 78	F. 56
14	F. 42	F. 58	F. 43	F. 43	C. 61	F. 47	F. 52	F. 68	F. 54	F. 41	F. 64	F. 50

Apr. 1857.	Glenwood, Tenn. 7 A.M.	2 P.M.	9 P.M.	Hillsboro', Ohio. 7 A.M.	2 P.M.	9 P.M.	Platteville, Wis. 7 A.M.	2 P.M.	9 P.M.	San Francisco, Cal. 7 A.M.	2 P.M.	9 P.M.
1	C. 51	C. 50	C. 45	C. 41	C. 42	F. 28	C. 35	F. 52	F. 30	C. 51	F. 65	F. 52
2	F. 32	F. 47	F. 40	F. 22	F. 33	F. 30	F. 24	F. 48	C. 36	C. 52	F. 69	F. 53
3	F. 34	F. 64	C 52	F. 30	F. 54	F. 46	C. 36	C. 56	F. 42	F. 55	F. 65	F. 54
4	C. 51	C. 61	C. 60	C. 43	C. 60	C. 50	C. 42	C. 54	C. 41	F. 54	F. 69	F. 59
5	R. 57	R. 37	C 30	C. 52	C. 56	C. 34	C. 26	C. 30	C. 18	F. 63	F. 75	F. 61
6	F. 22	F. 33	F. 30	F. 20	C. 23	C. 22	F. 12	C. 24	F. 20	F. 60	F. 82	F. 61
7	C 30	C. 60	C. 55	F. 22	C. 41	F. 39	S. 28	S. 38	S. 32	F. 62	F. 83	F. 64
8	C. 52	R. 44	R. 38	C. 47	R. 45	R. 34	F. 31	C. 38	F. 27	F. 62	F. 70	F. 55
9	F. 36	C. 46	F. 40	C. 32	C. 43	F. 38	F. 28	C. 54	C. 42	F. 54	F. 68	F. 52
10	F. 34	C. 62	C. 46	F 33	? 49	C. 39	R. 38	R. 28	R. 20	C. 52	F. 64	C. 53
11	C. 34	C. 39	C. 35	C. 38	C. 32	C. 28	F. 16	C. 34	F. 25	C. 54	F. 60	C. 52
12	F. 30	F. 47	F. 40	C. 28	F. 38	F. 33	F. 26	C. 34	R. 36	F. 54	F. 62	C. 52
13	F. 37	C. 56	C. 44	C. 31	C. 49	F. 36	C. 30	C. 34	F. 24	C. 54	C. 60	C. 53
14	F. 36	F. 49	F. 46	C. 32	C. 40	F. 35	F. 22	C. 38	F. 16	C. 53	C. 60	F. 54

15	C. 48 C. 51 F. 39	C. 36 C. 43 F. 35	C. 43 C. 47 C. 38	C. 37 C. 35 C. 30	F. 42 F. 49 F. 39	F. 43 C. 67 F. 56	? 45 ? 69 ? 58	C. 47 C. 78 F. 60	F. 38 F. 46 C. 39	F. 27 F. 37 C. 32	C. 14 F. 38 F. 26	C. 54 F. 64 C. 54
16	C. 39 F. 49 F. 36	F. 37 F. 42 F. 33	F. 42 F. 46 R. 38	C. 33 C. 39 ? 31	C. 37 C. 51 F. 42	C. 51 C. 60 F. 49	C. 54 ? 74 ? 63	C. 53 C. 72 F. 65	C. 32 F. 46 F. 40	F. 31 F. 38 F. 30	F. 16 F. 35 F. 20	C. 53 C. 58 C. 55
17	R. 38 R. 53 R. 46	C. 32 C. 41 C. 39	C. 37 C. 42 R. 40	C. 31 F. 39 ? 34	F. 36 F. 48 F. 40	F. 39 F. 56 F. 48	F. 52 C. 71 C. 69	C. 66 C. 83 F. 71	C. 36 C. 46 C. 48	F. 27 C. 44 C. 34	F. 30 C. 44 R. 30	C. 54 F. 62 F. 55
18	R. 39 R. 43 F. 37	C. 39 C. 42 F. 39	C. 44 C. 44 F. 40	F. 32 C. 46 C. 42	C. 37 R. 46 R. 42	C. 61 F. 77 R. 64	C. 50 R. 64 R. 60	C. 41 C. 50 F. 50	R. 51 C. 43 C. 39	C. 37 C. 44 C. 37	F. 25 C. 37 F. 27	C. 55 F. 64 F. 53
19	F. 36 F. 48 F. 37	F. 40 C. 53 C. 44	C. 40 C. 44 F. 38	C. 43 S. 37 S. 36	R. 44 R. 45 R. 39	R. 58 R. 62 C. 61	R. 51 ? ? F. 64	C. 45 F. 69 F. 54	C. 35 F. 47 F. 42	C. 33 C. 38 F. 35	F. 26 C. 44 F. 32	C. 54 F. 59 C. 55
20	F. 35 F. 53 F. 56	C. 37 C. 51 C. 43	C. 42 R. 44 R. 45	S. 34 S. 34 S. 34	R. 37 C. 44 C. 44	F. 46 F. 58 F. 45	F. 50 F. 71 F. 58	F. 53 F. 79 F. 64	F. 33 F. 62 C. 52	F. 33 F. 46 F. 42	C. 32 F. 52 C. 34	C. 55 C. 62 C. 55
21	F. 35 F. 44 F. 34	C. 38 F. 46 F. 38	R. 42 R. 39 C. 35	S. 34 C. 38 ? 38	C. 42 C. 43 R. 41	C. 48 F. 70 R. 50	F. 50 F. 73 F. 59	C. 66 C. 72 C. 60	F. 48 C. 45 F. 41	C. 39 C. 48 C. 42	C. 32 C. 44 S. 37	C. 54 F. 65 F. 56
22	C. 36 F. 43 C. 34	F. 40 F. 52 F. 40	C. 39 C. 40 C. ?	? 32 F. 48 C. 40	R. 36 C. 51 C. 47	F. 47 C. 54 F. 48	F. 48 F. 63 F. 50	F. 50 C. 61 C. 54	C. 38 C. 46 F. 43	C. 34 C. 45 F. 41	F. 36 F. 54 F. 45	F. 60 C. 70 F. 57
23	C. 34 C. 36 C. 36	C. 36 C. 46 F. 41	C. 45 F. 50 F. 44	C. 36 C. 40 F. 43	F. 46 F. 55 F. 45	F. 46 F. 58 F. 49	F. 44 F. 64 F. 54	F. 46 F. 70 F. 49	F. 41 C. 60 R. 50	F. 40 C. 53 F. 47	F. 37 F. 50 F. 38	C. 55 F. 61 F. 54
24	C. 40 F. 54 F. 43	C. 40 F. 55 F. 45	F. 45 F. 52 F. 42	F. 38 F. 52 C. 44	F. 42 F. 56 F. 46	C. 50 F. 65 F. 56	F. 42 F. 65 F. 60	C. 48 C. 70 C. 63	F. 39 F. 61 F. 53	F. 41 F. 57 F. 49	F. 34 C. 54 C. 46	F. 59 F. 68 F. 56
25	F. 41 F. 58 C. 42	C. 42 C. 44 F. 34	F. 46 F. 52 F. 44	F. 37 F. 51 ? 42	C. 48 C. 62 F. 53	F. 55 F. 70 C. 61	F. 48 F. 66 C. 62	C. 61 C. 80 C. 67	C. 45 F. 70 F. 62	C. 46 F. 60 F. 54	F. 42 R. 52 R. 42	F. 60 F. 71 F. 57
26	C. 40 F. 50 C. 40	C. 37 F. 50 F. 38	F. 46 F. 54 F. 42	? 38 C. 46 R. 42	F. 46 F. 65 C. 55	F. 57 F. 73 F. 63	F. 54 C. 72 F. 66	C. 66 C. 78 C. 70	C. 53 R. 57 F. 49	C. 49 C. 61 C. 46	C. 38 C. 42 C. 34	F. 61 F. 74 F. 58
27	F. 40 F. 52 C. 42	R. 38 R. 35 C. 36	C. 45 C. 51 C. 45	C. 45 C. 43 C. 38	C. 52 F. 65 F. 51	C. 66 C. 76 F. 67	C. 62 R. 75 F. 69	R. 48 C. 49 C. 48	F. 45 C. 57 F. 51	F. 42 C. 44 F. 39	F. 32 F. 60 F. 46	F. 62 F. 75 F. 56
28	C. 48 F. 51 F. 44	C. 39 C. 40 C. 34	F. 46 F. 54 F. 44	F. 37 F. 49 ? 38	C. 48 F. 62 C. 58	C. 58 C. 63 R. 56	FOG. 65 R. 73 C. 64	C. 50 C. 68 C. 62	C. 45 C. 62 F. 55	F. 41 C. 55 F. 45	C. 40 C. 62 C. 50	C. 59 F. 66 F. 54
29	F. 40 F. 46 F. 36	F. 38 C. 43 F. 33	F. 46 F. 52 F. 43	F. 35 F. 49 F. 44	C. 49 F. 61 F. 51	C. 57 C. 69 F. 62	C. 58 C. 66 C. 68	C. 65 C. 84 C. 71	C. 46 F. 69 F. 58	F. 44 F. 60 F. 53	F. 46 F. 64 F. 50	C. 61 F. 71 F. 56
30	F. 37 F. 48 F. 35	F. 42 F. 45 F. 37	F. 46 F. 50 F. 40	F. 38 F. 55 F. 46	F. 45 F. 65 F. 57	F. 58 F. 68 C. 61	? 64 ? ? R. 70	C. 70 F. 74 F. 64	C. 57 C. 71 R. 62	F. 50 F. 69 F. 63	C. 48 C. 66 R. 52	F. 60 F. 70 C. 58

Register of the temperature and face of the sky, &c.—Continued.

May, 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.			Alexandria, Va.			All Saints, S. C.			Warrington, Fla.			Austin, Tex.			Glenwood, Tenn.			Hillsboro', Ohio.			Platteville, Wis.			San Francisco, Cal.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.H.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	F. 37	F. 50	F. 40	F. 46	C. 61	R. 50	F. 46	? 50	? 41	? 52	R. 55	R. 51	F. 50	C. 58	R. 55	R 63	C. 67	C. 65	C. 68	C 69	C. 67	C. 67	C. 64	C. 54	C. 64	C. 68	C. 65	C. 53	C. 60	C. 58	C. 46	C 50	F. 40	F. 58	F. 66	F. 55
2	F. 42	F. 60	F. 45	R. 43	R. 48	R. 49	C. 49	C. 59	C. 50	R. 53	R. 54	R. 44	C. 61	C. 64	C. 62	C. 68	R. 70	C. 69	C. 67	C. 70	C. 69	C. 50	C. 64	C. 53	C. 56	C. 60	C. 53	C. 54	C. 55	C 47	F. 35	F. 58	F. 46	F. 57	F. 68	F. 54
3	C. 53	C. 66	C. 50	C. 41	C. 48	F. 39	R. 52	C. 56	C. 49	R. 42	R. 49	R. 42	C. 60	C. 72	R. 68	C. 70	C. 74	C. 70	C. 68	R. 69	C. 68	C. 62	F. 76	F. 56	C. 48	C. 56	R. 49	C. 44	C. 49	C. 47	F. 44	F. 66	F. 57	C. 60	F. 70	F. 58
4	C. 50	C. 54	R. 49	C. 42	C. 54	R. 45	R. 52	C. 56	C. 52	R. 42	R. 42	R. 41	R. 60	C. 73	R. 68	C. 70	R. 71	F. 68	F. 58	F. 65	F. 65	F. 48	F. 92	F. 72	R. 48	R. 49	C. 51	C. 46	C. 64	C. 46	C. 48	C. 75	C. 60	F. 56	F. 66	F. 54
5	R. 58	R. 62	R. 48	C. 43	R. 40	R. 63	C. 54	C. 57	C. 50	R. 48	R. 56	R. 46	F. 63	F. 71	F. 60	F. 60	F. 74	F. 66	F. 66	F. 75	F. 70	F. 60	F. 88	F. 66	C. 50	F. 64	C. 56	C. 44	C. 47	F. 47	C. 48	C. 67	F. 48	F. 55	F. 64	F. 53
6	C. 56	C. 55	C. 43	C. 37	R. 44	R. 42	F. 52	F. 60	F. 49	R. 42	R. 45	R. 42	F. 58	C. 72	F. 62	F. 63	F. 73	C. 67	C. 70	F. 75	C. 71	C. 60	F. 83	F. 69	F. 56	C. 67	F. 56	F. 43	F. 55	F. 49	C. 48	F. 68	F. 59	F. 53	F. 62	F. 53
7	C. 49	F. 64	C. 55	C. 41	C. 49	C. 45	F. 55	F. 63	F. 47	C. 43	F. 60	F. 49	C. 53	F. 62	F. 59	C. 64	F. 72	C 64	F. 65	F. 76	F. 73	F. 64	C. 84	C. 67	F. 47	C. 69	F. 57	F. 48	F. 66	F. 58	F. 50	F. 70	F. 58	F. 57	F. 60	F. 54
8	C. 50	F. 58	F. 56	F. 51	F. 60	F. 48	F. 51	F. 56	F. 48	? 45	F. 63	? 54	F. 54	F. 72	F. 63	F. 61	F. 72	F. 65	F. 66	F. 77	F. 74	C. 68	F. 89	F. 67	C. 51	C. 76	C. 67	F. 56	F. 75	F. 63	C. 54	F 76	F. 70	F. 60	C. 71	F. 55
9	F. 47	F. 58	F. 55	C. 51	C. 75	F. 61	F. 54	F. 64	F. 49	C. 61	C. 79	F. 70	F. 58	F. 74	F. 62	F. 62	F. 74	F. 64	F. 69	F. 77	F. 77	C. 66	F. 88	C. 69	C. 64	F. 81	C. 73	C. 65	F. 76	F. 69	F. 66	F. 48	F. 39	F. 58	F. 68	F. 53
10	F. 55	F. 72	F. 55	C. 54	C. 58	R. 37	F. 55	F. 61	F. 53	F. 58	C. 50	C. 36	F. 63	F. 82	F. 70	F. 62	F. 77	F. 70	F. 75	F. 80	F. 78	C. 66	C. 89	C. 70	C. 65	F. 70	F. 57	F. 56	F. 57	C. 46	C. 34	F. 50	F. 43	C. 56	F. 66	C. 54
11	C. 46	C. 38	F. 34	C. 32	F. 42	F. 34	F. 51	F. 51	F. 44	C. 32	F. 41	? 40	C. 52	C. 53	C. 53	F. 69	F. 70	F. 64	F. 73	F. 77	F. 74	C. 70	F. 81	F. 72	R. 45	C. 54	F. 50	C. 37	C. 42	F. 35	C. 35	F. 59	F. 39	F. 54	F. 62	F. 54
12	F. 34	F. 46	F. 37	F. 45	C. 51	F. 44	C. 45	F. 52	F. 44	? 38	? 51	? 45	F. 50	F. 60	F. 53	C. 61	C. 65	C. 61	C. 74	F. 79	F. 76	C. 68	C. 85	C. 73	F. 47	F. 69	C. 63	F. 37	F. 55	F. 50	F. 33	F. 60	F. 48	F. 52	F. 64	F. 52
13	F. 43	F. 56	C. 47	F. 43	C. 64	F. 50	F. 51	F. 56	F. 48	? 42	C. 58	? 50	F. 54	C. 70	R. 62	C. 63	C. 70	R. 68	F. 74	F. 79	F. 75	C. 68	C. 85	F. 71	C. 60	C. 84	C. 75	C. 47	C. 53	C. 55	R. 42	R. 46	R. 46	F. 53	F. 61	C. 54
14	F. 47	F. 55	F. 41	F. 57	F. 58	C. 51	C. 51	F. 55	R. 50	C. 49	C. 55	C. 48	R. 60	R. 70	C. 68	C. 72	F. 82	C. 74	C. 74	F. 80	C. 77	C. 71	F. 92	F 81	C. 66	C. 79	F. 74	C. 63	F. 71	F. 66	R. 46	R. 46	C. 42	F. 55	F. 66	F. 54

15	F. 43 F. 56 C. 47	C. 45 C. 57 C. 49	C. 51 C. 57 C. 47	F. 46 C. 43 F. 45	C. 59 C. 63 F. 50	C. 71 C. 77 C. 71	C. 77 F. 80 C. 77	C. 70 C. 82 F. 74	F. 48 F. 70 F. 57	C. 54 C. 53 C. 49	C. 43 C. 48 F. 49	F. 54 F. 72 F. 53
16	C. 45 C. 52 F. 45	C. 45 C. 61 C. 50	C. 45 R. 46 C. 46	? 46 F. 63 C. 42	C. 57 F. 68 F. 59	F. 69 F. 73 C. 67	R. 73 R. 68 R. 68	C. 69 C. 88 C. 70	F. 51 C. 65 C. 60	F. 47 F. 63 F. 56	F. 54 F. 67 F. 50	F. 53 C. 65 F. 53
17	F. 43 F. 55 F. 42	R. 42 C. 47 C. 48	C. 47 C. 50 C. 42	C. 40 C. 44 ? 45	F. 56 F. 68 C. 59	C. 70 R. 72 C. 70	R 70 C. 73 C. 75	F. 58 F. 80 F. 62	C. 59 C. 69 C. 59	F. 45 F. 55 C. 51	F. 47 F. 65 F. 52	C. 54 C. 63 F. 51
18	F. 45 F. 49 F. 41	C. 43 C. 64 C. 50	C. 46 C. 50 C. 45	F. 41 ? 55 ? 47	C. 52 C. 57 R. 48	R. 70 R. 64 R. 67	F. 71 C. 74 F. 74	F. 53 F. 74 F. 58	R. 49 R. 46 C. 50	C. 44 C. 53 C. 47	F. 42 F. 60 F. 47	C. 54 F. 62 F. 51
19	F. 46 F. 62 C. 47	F. 44 C. 59 C. 47	C. 46 R. 46 R 45	C. 48 C. 56 C. 50	R. 47 R. 47 R. 42	C. 57 C. 65 F. 57	F. 59 F. 70 F. 60	F. 54 F. 80 F. 69	F. 48 C. 57 F. 51	C. 41 C. 45 C. 45	F. 44 F. 68 F. 52	F. 54 F. 65 F. 53
20	C. 46 F. 59 C. 44	C. 48 C. 59 F. 46	C. 45 C. 59 R. 50	C. 45 C. 46 C. 48	R. 46 C. 50 C. 51	F. 54 C. 64 F. 59	F. 61 F. 73 F. 73	C. 60 C. 78 C. 72	F. 54 F. 66 F. 54	F. 45 F. 59 F. 50	F. 47 F. 72 F. 55	C. 55 F. 66 F. 56
21	C. 46 F. 60 C. 49	C. 53 C. 72 C. 64	C. 44 R. 57 R. 47	C. 47 F. 73 F. 57	C. 51 F. 61 C. 58	F. 56 F. 70 F. 56	F. 63 F. 74 F. 74	C. 63 C. 75 F. 69	F. 46 C. 62 F. 54	F. 51 F. 64 F. 56	F. 52 F. 78 F. 65	C. 62 F. 78 F. 55
22	C. 49 F. 57 F. 48	F. 52 F. 76 C. 66	F. 52 F. 63 F. 48	? 55 ? 76 ? 63	F. 57 F. 74 F. 63	F. 55 C. 70 F. 60	F. 63 F. 75 F. 71	F. 60 C. 77 F. 67	F. 49 F. 72 F. 60	F. 55 F. 73 F. 62	F. 62 F. 82 F 70	F. 57 C. 61 F. 56
23	F. 52 F. 62 F. 47	F. 75 C. 78 F. 70	C. 52 F. 62 F. 51	? 61 ? 77 ? 65	F. 59 C. 80 C. 65	F. 60 F. 76 F. 66	F. 66 F. 77 F. 74	C. 63 C. 76 F. 69	F. 53 F. 78 F. 62	F. 61 C. 76 F. 68	F. 64 F. 88 F. 72	C. 55 F. 69 F. 59
24	F. 53 F. 68 F. 53	? 74 F. 84 F. 66	F. 59 F. 72 F. 53	? 60 ? 84 ? 71	F. 66 F. 82 F. 69	F. 64 F. 79 F. 69	F. 69 F. 75 F. 75	C. 64 C. 83 C. 70	F. 58 C. 78 F. 67	F. 65 F. 81 F. 67	R. 63 R. 82 R. 67	F. 65 F. 73 F. 58
25	F. 55 F. 70 F. 56	F. 79 F. 84 C. 75	F. 57 F. 66 F. 55	F. 67 F. 86 F. 73	F. 67 F. 84 F. 73	F. 65 F. 78 F. 65	F. 68 F. 77 F. 75	C. 65 C. 76 C. 70	F. 66 C. 76 R. 63	F. 67 C. 78 F. 67	C. 63 C. 67 F. 62	F. 61 F. 72 F. 53
26	C. 51 F. 56 F. 45	C. 53 C. 62 C. 57	F. 59 F. 71 F. 56	? 65 C. 67 C 68	F. 68 F. 83 F. 73	F. 63 F. 78 F. 71	C. 74 C. 78 C. 75	C. 66 F. 86 F. 71	C. 62 C. 75 C. 65	C. 60 C. 68 C. 59	R. 61 R. 66 R. 53	F. 58 F. 64 F. 56
27	F. 47 F. 64 C. 48	C. 69 C. 72 C. 67	C. 58 F. 67 F. 56	C. 66 C. 77 C. 62	C. 72 C. 80 C. 64	C. 72 F. 79 F. 72	F. 73 F. 79 F. 78	F. 71 C. 86 F. 74	F. 59 F. 75 C. 65	C. 58 C. 64 F. 61	C. 50 C. 58 C. 52	C. 58 F. 68 C. 54
28	C. 59 F. 75 F. 60	C. 61 C. 74 C. 61	R. 57 C. 65 C. 57	? 60 C. 63 F. 55	C. 66 F. 79 C. 68	F. 71 F. 81 F 76	F. 74 F. 83 F. 78	C. 72 C. 86 F. 76	C. 60 C. 70 F. 58	C. 55 F. 64 F. 57	C. 53 C 56 F. 48	C. 57 F. 65 C. 55
29	C. 65 C. 72 C. 62	F. 64 C. 64 F. 59	C. 58 C. 65 C. 61	? 57 C. 62 C. 54	F. 63 C. 78 C. 60	F. 71 F. 83 F. 70	F. 79 F. 80 F. 78	C. 72 C. 86 C. 74	F. 57 C. 75 C. 63	F. 54 C. 64 F. 55	F. 48 C. 70 F. 61	C. 56 F. 69 C. 59
30	C. 63 F. 72 F. 54	F. 58 C. 59 F. 53	F. 60 F. 65 F. 53	C. 53 F. 66 ? 59	C. 64 F. 76 C. 69	F. 67 F. 81 F. 76	F. 76 F. 83 F. 77	C. 69 C. 86 F. 72	R. 57 C. 70 C. 63	C. 55 C. 63 C. 59	C. 61 C. 62 C. 58	F. 54 C. 64 C. 56
31	F. 55 F. 65 F. 53	C. 58 C. 65 F. 59	C. 60 F. 64 C. 58	C. 57 C. 72 C. 63	C. 70 F. 83 C. 76	C. 77 C. 82 C. 77	C. 75 R. 72 C. 71	C. 64 C. 81 C. 61	C. 63 C. 67 C. 66	F. 61 C. 68 C. 63	C. 56 C. 62 C. 58	?

Register of the temperature and face of the sky, &c.—Continued.

June, 1857.	Wolfville, Nova Scotia. 7 A.M.	2 P.M.	9 P.M.	Montreal, Canada. 7 A.M.	2 P.M.	9 P.M.	Nantucket, Mass. 7 A.M.	2 P.M.	9 P.M.	Rochester, N. Y. 7 A.M.	2 P.M.	9 P.M.
1	F. 57	F. 69	F. 61	C. 57	C. 73	C. 63	C. 58	R. 65	R. 58	R. 65	R. 68	C. 63
2	R. 58	C. 68	C. 61	F. 67	C. 76	C. 62	C. 58	C. 64	C. 56	C. 60	F. 66	F. 54
3	C. 65	F. 67	F. 57	C. 56	C. 65	F. 60	F. 56	F. 68	F. 57	C. 58	F. 69	R. 51
4	F. 59	C. 62	F. 52	F. 61	C. 61	F. 53	F. 60	F. 67	C. 59	F. 50	C. 55	F. 52
5	F. 52	F. 59	C. 53	F. 53	C. 59	C. 51	C. 57	C. 62	F. 53	? 48	C. 57	F. 48
6	F. 51	C. 60	C. 55	C. 54	C. 58	C. 55	F. 56	F. 65	F. 54	C. 58	C. 70	C. 59
7	C. 52	C. 60	C. 50	C. 53	C. 65	F. 59	C. 57	R. 57	R. 55	R. 53	C. 56	C. 57
8	F. 53	F. 60	C. 50	F. 60	F. 70	F. 64	F. 58	F. 64	F. 50	F. 59	R. 65	R. 66
9	F. 53	F. 65	F. 53	F. 64	C. 75	C. 66	F. 58	F. 66	C. 54	C. 63	C. 65	C. 59
10	? 58	F. 69	? 50	C. 64	F. 76	F. 69	C. 58	C. 64	C. 55	C. 58	C. 65	F. 65
11	? 58	F. 74	R. 59	R. 64	R. 63	R. 61	C. 55	R. 60	R. 58	R. 62	R. 64	R. 54
12	R. 61	C. 73	C. 60	C. 60	C. 66	C. 63	F. 60	F. 65	C. 57	F. 55	R. 69	R. 60
13	C. 62	C. 64	F. 58	C. 69	F. 70	F. 60	F. 61	C. 70	C. 59	R. 61	R. 72	? 58
14	F. 64	C. 67	F. 58	F. 56	C. 63	F. 57	F. 67	F. 71	F. 59	? 53	C. 66	F. 63

June, 1857.	Alexandria, Va. 7 A.M.	2 P.M.	9 P.M.	All Saints, S. C. 7 A.M.	2 P.M.	9 P.M.	Warrington, Fla. 7 A.M.	2 P.M.	9 P.M.	Austin, Tex. 7 A.M.	2 P.M.	9 P.M.
1	C. 72	C. 82	C. 75	C. 77	R. 80	R. 74	C. 75	C. 77	F 75	C. 65	C. 80	F. 68
2	C. 72	R. 79	F. 68	C. 74	C. 79	F. 72	F. 75	F. 77	F. 76	F. 66	C. 84	F. 70
3	F. 69	F. 81	F. 76	F. 70	F. 77	F. 74	F. 71	F. 82	F. 80	F. 65	F. 88	F. 74
4	F. 69	F. 80	C. 61	F. 71	? ?	F. 74	F. 76	F. 82	F. 80	F. 67	F. 88	F. 75
5	R. 55	F. 68	F. 57	F. 74	F. 85	C. 74	F. 74	F. 85	F. 83	C. 73	C. 88	C. 77
6	F. 58	F. 70	F. 65	F. 66	C. 72	C. 70	F. 77	F. 84	F. 81	C. 73	F. 92	C. 78
7	F. 64	F. 80	F. 72	F. 70	F. 77	F. 74	F. 81	F. 83	F. 81	C. 74	C. 92	C. 80
8	F. 70	F. 80	C. 70	F. 75	C. 78	F. 78	F. 79	F. 84	F. 81	C. 73	C. 94	C. 77
9	C. 70	R. 77	R. 70	F. 78	F. 83	F. 81	F. 80	F. 82	F. 81	C. 80	C. 92	F. 77
10	C. 68	F. 76	C. 69	F. 79	C. 83	C. 81	F. 80	F. 83	F. 81	C. 74	C. 90	F. 80
11	C. 67	F. 80	F. 65	C. 74	F. 87	F. 81	F. 81	F. 80	F. 81	C. 76	R. 74	F. 74
12	F. 66	C. 79	F. 75	F. 74	F. 80	F. 77	F. 78	F. 82	F. 83	C. 74	C. 90	F. 80
13	C. 72	C. 84	C. 78	F. 78	F. 83	F. 80	F. 81	F. 84	F. 81	C. 72	C. 84	F. 77
14	C. 75	F. 86	F. 78	C. 81	C. 84	F. 80	F. 82	F. 85	F. 82	C. 76	C. 87	F. 77

June, 1857.	Glenwood, Tenn. 7 A.M.	2 P.M.	9 P.M.	Hillsboro', Ohio. 7 A.M.	2 P.M.	9 P.M.	Franklin, Iowa. 7 A.M.	12 M.	9 P.M.	San Francisco, Cal. 7 A.M.	2 P.M.	9 P.M.
1	C. 63	C. 72	C. 63	C. 60	F. 71	C. 61	F. 52	F. 65	F. 51	C. 56	C. 62	C. 58
2	F. 62	F. 72	F. 62	F. 53	F. 67	F. 61	C. 48	C. 70	F. 54	C. 57	C. 62	C. 58
3	F. 61	F. 80	F. 67	C. 59	F. 76	F. 66	F. 52	C 62	F. 50	C. 58	C. 64	C. 57
4	F. 62	C. 79	C. 62	C. 54	C. 54	C. 52	F. 56	F. 65	F. 51	C. 58	F. 62	F. 56
5	C. 58	F. 70	F. 60	F. 50	F. 64	C. 57	C. 52	F. 72	F. 55	F. 58	F. 67	C. 58
6	C. 55	F. 75	F. 68	F. 53	F. 70	F. 60	F. 66	F. 80	F. 66	F. 59	C. 66	C. 56
7	C. 66	C. 84	F. 77	F. 59	F. 76	F. 68	F. 80	F. 90	C. 65	C. 58	F. 66	C. 54
8	F. 77	R. 86	C. 79	F. 70	F. 85	F. 77	C. 70	C. 72	F. 60	C. 56	C. 69	F. 54
9	C. 70	R. 76	R. 73	C. 69	F. 79	F. 70	F. 63	F. 80	F. 67	F. 59	F. 73	C. 56
10	C. 68.5	R. 74	C. 72	F. 66	C. 77	C. 63	C. 62	C. 72	F. 57	F. 60	F. 82	F. 63
11	C. 64	C. 74	F. 65	F. 61	F. 67	F. 62	C. 64	F. 80	C. 66	F. 66	F. 75	F. 61
12	C. 64	F. 82	F. 76	F. 62	C. 69	F. 69	C. 59	F. 81	F. 61	F. 62	F. 72	F. 57
13	C. 76	C. 88	C. 77	C. 67	C. 78	C. 63	C. 54	C. 73	F. 60	F. 60	F. 66	F. 55
14	F. 70	C. 83	F. 75	C. 65	C. 73	? 68	C. 66	F. 90	C. 77	F. 59	F. 70	F. 55

15	C. 54 C. 59 F. 59	F. 57 F. 67 F. 66	F. 62 F. 70 F. 56	C. 59 C. 65 C. 60	F. 77 F. 86 F. 73	F. 81 C. 86 F. 82	F. 81 F. 84 F. 81	F. 74 C. 88 F. 77	C. 71 C. 85 F. 77	F. 69 F. 82 F. 76	C. 68 C. 82 C. 66	F. 60 F. 71 F. 57
16	F. 51 F. 61 F. 59	C. 57 C. 63 C. 57	C. 62 C. 66 F. 56	R. 58 R. 58 C. 57	F. 75 C. 88 C. 77	F. 78 F. 84 F. 80	F. 82 F. 85 F. 84	C. 70 C. 75 C. 74	C. 75 C. 85 R. 72	F. 72 F. 83 C. 68	C. 64 C. 67 C. 55	F. 66 F. 98 F. 73
17	C. 57 F. 70 C. 57	R. 53 C. 58 C. 55	F. 56 C. 65 C. 66	C. 63 R. 64 R. 63	C. 75 F. 86 R. 74	F. 79 F. 81 F. 77	F. 82 F. 84 C. 82	F. 74 F. 87 F. 74	C. 66 C. 76 F. 67	C. 68 F. 76 F. 64	C. 51 C. 56 C. 50	F. 70 F. 75 F. 55
18	F. 64 C. 70 C. 59	C. 55 C. 58 C. 57	C. 54 C. 66 C. 60	C. 63 C. 73 F. 64	C. 75 C. 84 F. 78	F. 78 C. 78 C. 74	F. 75 F. 84 F. 76	F. 75 F. 88 F. 72	F. 61 C. 64 C. 60	C. 62 C. 65 F. 57	C. 52 C. 64 F. 59	F. 59 F. 66 C. 56
19	R. 56 C. 57 C. 54	C. 67 C. 70 C. 63	C. 62 C. 73 C. 64	F. 61 C. 72 C. 61	C. 68 C. 79 F. 74	C. 72 C. 78 F. 76	F. 70 F. 78 F. 78	F. 68 F. 84 F. 72	F. 57 C. 73 F. 67	C. 56 F. 68 F. 59	F. 56 F. 70 F. 49	C. 55 F. 65 F. 55
20	C. 61 C. 73 C. 68	F. 71 F. 74 C. 67	C. 62 C. 68 C. 61	? 60 C. 73 R. 61	F. 72 F. 83 F. 77	C. 75 C. 78 F. 75	F. 73 F. 83 F. 82	F. 66 F. 89 F. 74	C. 67 C. 79 F. 71	C. 58 F. 69 F. 61	F. 52 C. 72 F. 54	F. 57 F. 64 C. 54
21	C. 70 F. 80 C. 71	F. 69 C. 73 F. 65	C. 65 C. 68 C. 62	C. 67 C. 72 C. 62	C. 77 C. 85 R. 70	R. 73 C. 75 C. 75	F. 82 F. 84 F. 82	F. 66 F. 89 F. 81	C. 66 F. 74 F. 64	F. 58 C. 68 F. 60	F. 59 F. 70 F. 62	F. 57 F. 71 F. 54
22	R. 70 C. 82 C. 69	C. 61 C. 70 C. 60	C. 64 C. 69 C. 60	R. 65 R. 60 R. 58	F. 69 F. 75 F. 64	C. 76 C. 79 C. 78	F. 80 F. 84 C. 72	F. 74 F. 90 F. 81	F. 60 F. 73 F. 61	F. 53 F. 63 F. 57	F. 70 F. 85 F. 64	F. 56 F. 66 F. 53
23	C. 65 C. 73 C. 60	C. 58 C. 66 C. 58	F. 60 C. 68 F. 60	F. 54 C. 65 C. 59	F. 64 F. 73 F. 63	C. 67 F. 73 C. 73	C. 73 C. 73 C. 75	F. 74 C. 90 F. 82	F. 58 C. 74 F. 63	F. 52 F. 69 F. 58	C. 69 C. 74 C. 66	F. 54 F. 63 F. 54
24	F. 63 F. 70 C. 61	C. 64 C. 73 F. 68	F. 62 F. 68 F. 60	F. 57 C. 73 ? 63	F. 69 F. 78 F. 70	F. 71 R. 77 R. 76	C. 79 F. 83 F. 78	F. 73 F. 90 F. 78	C. 59 F. 78 F. 72	F. 57 F. 74 F. 64	C. 66 C. 78 F. 61	C. 56 F. 66 C. 55
25	C. 65 C. 64 C. 62	C. 61 R. 69 F. 73	F. 66 F. 72 C. 60	C. 60 F. 82 F. 68	F. 74 F. 85 F. 73	C. 76 F. 80 F. 77	F. 79 F. 82 F. 81	F. 73 F. 92 F. 81	C. 67 F. 81 F. 74	F. 61 F. 78 F. 69	F. 66 C. 88 F. 70	F. 56 F. 68 F. 55
26	C. 62 C. 67 C. 57	F. 70 F. 76 C. 79	F. 68 F. 76 F. 66	? 65 C. 83 F. 72	F. 72 F. 87 F. 79	F. 72 F. 79 F. 77	C. 78 F. 83 F. 82	F. 74 C. 95 F. 84	C. 70 R. 77 F. 68	F. 65 F. 82 F. 72	F. 74 F. 83 F. 74	F. 59 F. 74 F. 58
27	C. 58 C. 67 C. 65	F. 67 C. 73 F. 67	F. 68 F. 76 F. 62	C. 69 ? 82 C. 75	F. 75 F. 89 F. 76	F. 74 F. 82 F. 79	C. 81 C. 86 C. 81	F. 75 F. 95 F. 84	C. 68 C. 73 C. 72	F. 67 C. 77 F. 72	F. 65 F. 90 F. 76	F. 60 F. 70 F. 54
28	C. 57 C. 66 C. 56	F. 66 F. 77 F. 70	F. 60 F. 66 F. 58	C. 69 ? 86 F. 77	F. 80 C. 90 C. 76	F. 77 F. 82 C. 78	F. 82 F. 85 F. 84	C. 76 F. 95 C. 85	C. 71 F. 81 C. 67	C. 68 C. 74 F. 67	F. 58 F. 69 F. 60	F. 54 F. 65 P. 54
29	C. 57 C. 65 C. 63	F. 66 C. 75 C. 68	F. 68 C. 74 F. 58	R. 69 R. 63 R. 63	R. 72 R. 74 C. 68	C. 77 F. 85 C. 76	F. 85 C. 95 F. 83	C. 71 C. 88 C. 80	F. 67 F. 78 F. 67	F. 62 F. 76 F. 68	C. 65 F. 77 F. 60	F. 55 C. 65 C. 54
30	C. 59 R. 62 C. 57	C. 65 C. 67 C. 60	C. 54 C. 62 C. 56	? 60 F. 71 C. 59	F. 69 C. 75 C. 66	F. 71 F. 82 F. 76	F. 81 F. 87 F. 90	F. 75 C. 91 F. 84	F. 68 C. 77 F. 70	F. 62 F. 72 F. 63	F. 61 F. 70 F. 60	C. 54 C. 60 F. 55

Register of the temperature and face of the sky, &c.—Continued.

July, 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	F. 56	C. 64	C. 56	C. 61	C. 67	C. 60	C. 56	C. 58	C. 54	C. 57	C. 63	? 60
2	F. 59	F. 68	F. 60	C. 65	F. 72	C. 62	C. 54	C. 60	C. 54	C. 59	C. 63	? 57
3	F. 62	F. 73	C. 53	F. 66	F. 77	F. 66	C. 55	C. 62	C. 56	57	? 68	56
4	C. 57	F. 66	F. 56	C. 67	F. 78	F. 68	C. 57	C. 66	C. 58	60	? 73	59
5		?		F. 67	F. 75	F. 64	F. 64	F. 72	C. 62	60	? 80	32
6		?		C. 64	C. 81	F. 70	C. 63	C. 74	C. 60	? 64	F. 77	F. 66
7	F. 71	F. 81	C. 66	C. 68	C. 72	F. 68	C. 63	C. 69	F. 62	? 65	C. 78	C. 67
8	C. 64	F. 68	C. 57	F. 66	F. 76	F. 69	F. 67	F. 76	F. 60	F. 62	C. 82	? 68
9	F. 59	C. 67	F. 65	C. 74	C. 79	F. 70	F. 66	F. 81	F. 62	61	? 80	67
10	F. 61	F. 74	C. 63	C. 65	F. 82	F. 72	F. 68	F. 75	C. 71	? 71	F. 82	? 76
11	C. 66	F. 76	C. 67	C. 71	F. 88	F. 81	F. 66	F. 75	F. 63	? 72	F. 86	? 76
12	C. 69	F. 78	F. 63	C. 74	C. 90	C. 75	C. 68	F. 84	F. 68	74	? 90	77
13	F. 63	F. 76	F. 60	F. 83	C. 90	F. 80	F. 68	F. 79	F. 63	? 74	F. 93	? 78
14	C. 60	F. 72	? ?	F. 78	C. 93	F. 80	C. 63	C. 74	C. 64	? 75	F. 95	F. 76

July, 1857.	Alexandria, Va.			All Saints, S. C.			Warrington, Florida.			Austin, Tex.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	C. 70	C. 72	C. 63	F. 74	C. 80	F. 76	F. 80	F. 86	C. 75	C. 74	C. 91	F. 81
2	C. 59	C. 63	C. 60	F. 71	C. 79	C. 76	F. 78	F. 87	F. 82	C. 77	C. 94	F. 74
3	C. 58	C. 66	F. 60	F. 66	C. 74	C. 72	F. 73	C. 85	F. 82	C. 72	C. 84	F. 76
4	C. 62	C. 76	F. 67	C. 65	F. 75	C. 74	F. 77	F. 84	F. 79	C. 69	F. 84	F. 75
5	C. 66	C. 79	C. 70	F. 64	F. 75	F. 74	F. 79	F. 86	F. 81	F. 70	C. 83	C. 78
6	F. 66	F. 78	F. 74	F. 74	? 78	F. 76	F. 76	F. 85	F. 79	C. 72	C. 82	F. 74
7	F. 72	F. 80	F. 73	F. 72	F. 81	C. 77	F. 77	F. 85	F. 80	C. 72	C. 84	C. 76
8	F. 73	F. 86	F. 77	F. 74	F. 79	C. 76	F. 82	F. 86	F. 79	F. 72	C. 88	F. 79
9	C. 77	C. 86	C. 76	C. 75	C. 82	F. 79	F. 76	C. 83	C. 78	F. 73	C. 90	F. 76
10	C. 78	C. 86	C. 76	R. 77	C. 79	F. 78	C. 77	C. 82	F. 80	F. 71	C. 86	C. 74
11	C. 76	C. 83	C. 73	C. 77	C. 77	C. 77	C. 79	F. 84	F. 79	C. 70	C. 85	F. 73
12	F. 74	F. 83	F. 76	C. 74	C. 81	C. 79	C. 81	C. 84	C. 80	C. 70	C. 87	F. 79
13	F. 78	F. 88	F. 82	R. 74	R. 81	C. 78	C. 81	C. 83	R. 79	C. 72	C. 91	F. 83
14	F. 75	F. 85	F. 79	C. 73	C. 81	F. 79	F. 82	F. 85	C. 80	F. 75	C. 92	F. 82

July, 1857.	Glenwood, Tenn.			Hillsboro, Ohio.			Platteville, Wis.			San Francisco Cal.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	F. 60	C. 71	F. 61	F. 53	C. 59	? 57	F. 62	F. 72	F. 68	F. 54	C. 66	F. 55
2	F. 60	C. 66	F. 60	C. 57	F. 67	? 59	C. 60	F. 75	F. 68	F. 56	F. 67	F. 56
3	F. 59	C. 66	F. 60	C. 55	C. 65	F. 60	F. 62	F. 82	F. 69	F. 58	F. 73	F. 61
4	F. 60	C. 71	F. 62	F. 58	C. 69	F. 62	F. 68	F. 93	F. 71	F. 62	F. 72	F. 56
5	F. 60	C. 75	F. 62	F. 60	C. 75	C. 59	F. 76	F. 92	F. 70	F. 63	F. 67	F. 57
6	F. 59	C. 79	F. 67	F. 57	C. 65	C. 63	F. 65	F. 90	F. 71	C. 60	F. 66	F. 55
7	C. 64	C. 79	F. 69	F. 62	F. 77	F. 68	F. 70	F. 98	F. 78	C. 55	F. 66	F. 54
8	F. 65	C. 81	F. 69	F. 68	C. 80	? 67	F. 74	F. 96	F. 80	F. 56	F. 65	F. 54
9	F. 65	C. 83	C. 72	C. 65	F. 81	C. 69	F. 80	F. 98	F. 80	F. 57	F. 67	F. 55
10	F. 66	F. 86	F. 74	F. 67	C. 76	F. 66	F. 78	F. 97	F. 79	C. 54	C. 63	C. 55
11	F. 70	C. 88	F. 75	F. 66	F. 80	F. 72	F. 77	F. 96	F. 80	C. 55	C. 67	C. 57
12	F. 72	C. 73	F. 71	F. 70	C. 76	F. 73	C. 78	R. 75	C. 74	C. 55	F. 64	C. 55
13	F. 70	C. 84	F. 76	F. 68	F. 85	F. 71	C. 72	C. 88	C. 74	C. 56	F. 64	F. 55
14	R. 70	C. 80	F. 74	C. 72	C. 83	C. 72	C. 70	R. 88	R. 78	C. 57	F. 67	F. 55

15	?	C. C. C. 79 85 78	C. C. C. 68 78 66	? ? R. 75 84 72	C. F. F. 77 87 77	R. R. F. 78 75 77	F. C. F. 83 85 80	C. C. F. 76 94 83	F. F. F. 71 85 74	C. C. F. 69 81 72	F. C. F. 76 94 82	C F. F. 57 68 55
16	C. F. C. 62 76 ?	C. R. C. 78 82 71	C. F. C. 68 78 68	C. C. C. 71 84 75	C. C. F. 78 78 74	R. R. R. 74 79 77	F. F. C. 81 84 80	C. F. F. 76 94 83	F. F. F. 69 87 76	F. F. ? 70 83 74	F. C. F. 74 94 82	F. F. F. 60 73 59
17	C. F. C. 64 77 66	C. C. C. 72 80 75	C. C. C. 74 81 68	? F. ? 73 83 74	C. F. F. 73 83 75	R. C. R. 74 79 77	F. F. F. 82 84 80	F. F. F. 76 98 86	F. C. F. 71 88 76	F. F. F. 72 87 77	F. C. C. 86 10 86	F. F. C. 62 69 59
18	C. C. F. 77 79 73	C. F. F. 72 85 77	C. C. F. 68 76 68	? F. ? 75 90 78	F. C. F. 75 86 81	F. C. F. 75 81 79	F. F. F. 83 85 80	F. F. F. 81 100 87	C. C. F. 74 86 78	C. C. F. 71 80 73	F. C. F. 82 92 84	C. F. F. 58 69 57
19	C. F. C. 74 80 67	C. C. C. 77 68 72	F. F. F. 72 79 68	C. ? F. 78 91 78	F. F. C. 77 84 81	F. C. C. 79 85 81	C. C. F. 80 83 80	F. C. F. 79 94 84	F. C. F. 73 89 83	C. F. F. 70 83 78	F. F. F. 74 92 78	F. F. F. 56 66 55
20	F. C. C. 72 79 69	C. C. F. 74 77 71	F. F. C. 70 79 70	C. C. ? 74 82 70	F. C F. 79 [illegible] 79	C. C. C. 79 86 81	F. F. F. 80 83 80	F. C. F. 74 94 81	R. F. C. 73 82 78	F. F. C. 74 84 70	F. C F. 68 84 68	C. F. F. 55 68 54
21	C. C. C. 75 86 78	C. C. F. 71 74 72	C. C. ? 70 77 69	C. C. C. 66 69 66	C. F. C. 77 85 78	C. F. F. 77 87 82	C. C. F. 81 88 80	F. C. F. 77 94 86	C. C. F. 74 73 70	F. C. F. 64 73 64	F. C. C. 66 82 74	F. F. F. 55 67 54
22	C. C. C. 72 66 55	C. C. C. 69 72 61	C. C. C. 69 80 70	C. F. C. 66 78 70	F. F. C. 76 83 75	F. C. R. 78 86 77	F. F. F. 83 83 80	F. C. C. 79 96 85	F. C. C. 65 76 68	C. C. C. 59 64 63	F. F. F. 62 82 78	F. F. F. 58 70 55
23	C. C. R. 62 69 62	C. C. R. 61 67 61	C. C. F. 68 71 68	C. C. C. 66 67 68	C. C. C. 71 71 70	F. F. F. 75 84 81	C. C. F. 80 83 80	C. C. C. 77 84 77	F. C. F. 65 77 70	C. F. F. 61 72 65	F. F. F. 64 92 70	C. F. F. 54 62 55
24	C. C. F. 64 77 70	C. C. C. 65 79 68	C. C. C. 69 78 70	C. R. F. 66 70 66	C. C. F. 72 81 75	R. R. R. 74 75 73	R. C. F. 80 84 79	C. C. C. 77 94 78	F. C. F. 67 80 71	F. C. F. 63 75 65	F. F. F. 66 87 74	C. F. F. 55 67 56
25	C. C. C. 77 82 72	C. C. C. 73 78 73	R. C. F. 70 77 69	C. F. ? 67 83 73	C. C. F. 76 83 78	C. C. C. 74 81 80	C. C. F. 80 85 80	F. C. F. 76 92 80	F. C. F. 67 84 74	F. F. F. 65 79 71	F. F. F. 64 89 60	F. F. F. 56 64 55
26	C. C. F. 70 83 70	F. F. F. 76 84 75	C. C. C. 72 80 71	F. ? ? 74 84 79	C. F. F. 78 86 76	C. C. F. 81 82 79	F. F. F. 81 85 80	C. C. F. 74 93 82	C. C. F. 73 70 74	F. F. F. 69 86 75	C. R. C. 77 80 72	C. C. F. 58 64 57
27	F. F. F. 73 88 71	C. C. F. 75 89 78	C. F. C. 72 89 70	? F. ? 76 92 81	C. F. F. 78 85 79	C. C. F. 80 82 80	R. R. C. 77 80 76	C. C. C. 75 93 80	F. R. R. 73 81 73	F. C. F. 71 75 74	R. C. F. 74 78 68	C. F. C. 56 66 53
28	C. F. C. 70 85 72	C. C. C. 85 81 68	F. F. F. 73 78 74	C. C. F. 77 71 68	C. F. C. 76 87 75	C. C. C. 80 82 81	C. C. F. 80 84 80	C. C. F. 76 88 79	R. C. C. 71 74 73	C. C. C. 70 74 70	F. F. F. 63 83 70	C. C. C. 54 63 58
29	C. R. C. 73 78 73	F. F. F. 71 76 68	C. C. C. 71 75 70	? 65 78 70	C. C. C. 80 83 76	F. C. C. 80 83 81	F. F. F. 80 84 81	C. C. F. 76 92 82	C. R. R. 72 76 74	C. C. C. 64 72 68	C. F. F. 68 90 78	C. F. C. 59 66 56
30	F. C. C. 65 79 74	C. C. F. 68 79 69	C. C. R 70 70 62	F. C. C. 65 77 67	R. C. F. 73 80 74	F. C. F. 81 87 81	C. C. C. 79 84 78	C. C. F. 78 94 84	C. C. C. 72 82 76	C. C. F. 65 74 70	C. C. F. 73 92 72	C. F. F. 57 67 58
31	C. C. C. 60 70 65	C. C. C. 73 71 65	C. C. C. 64 70 62	F. ? F. 67 85 66	C. F. F. 72 82 77	C. C. R. 81 81 77	C. C. C. 79 85 78	C. C. C. 77 96 84	C. C. C. 73 79 74	F. F. C. 69 81 74	F. F. F. 73 90 72	C. F. F. 58 69 58

Register of the temperature and face of the sky, &c.—Continued.

Aug., 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	C. 63	C. 73	C. 63	C. 65	C. 75	F. 64	C. 61	C. 70	C. 64	F. 71	F. 78	F. 64
2	C. 64	C. 75	C. 64	C. 65	C. 71	F. 67	F. 72	F. 76	F. 67	F. 70	F. 80	F 64
3	C. 64	C. 70	F. 63	C. 66	C. 74	C. 69	F. 73	F. 76	C. 62	F. 78	F. 85	F. 80
4	C. 63	C. 77	C. 62	C. 76	C. 83	C. 75	F. 70	F. 79	F. 69	F. 78	R. 92	F. 79
5	C. 64	C. 80	C. 60	C. 66	C. 75	F. 70	C. 70	C. 68	F 66	C. 74	F. 80	F. 75
6	C. 63	F. 75	F. 60	F. 67	F. 77	F. 68	F. 69	F. 73	C. 64	F. 70	? 81	F. 68
7	F. 60	F. 80	F. 65	F. 63	F. 81	C. 73	F. 65	F. 72	C. 61	F. 74	F. 86	F. 70
8	C. 63	F. 84	F. 65	C. 72	R. 83	F. 71	C. 61	C. 70	C. 67	F. 75	F. 89	C. 76
9	F. 66	F. 75	F. 65	F. 65	F. 71	F. 63	C. 72	F. 72	F. 62	F. 74	F. 78	F. 65
10	C. 56	F. 72	C. 65	C. 65	C. 76	C. 68	F. 69	F. 73	C. 66	C. 70	R. 78	F. 65
11	C. 68	C. 66	C. 63	F. 63	R. 68	C. 64	C. 69	F. 79	F. 68	C. 69	F. 78	F. 68
12	F. 59	F. 64	F. 55	F. 63	F. 72	C. 65	F. 70	F. 75	C. 66	F. 70	F. 78	C. 70
13	F. 55	F. 74	C. 64	C. 64	C. 72	R. 65	C. 69	C. 76	C. 71	F. 78	F. 88	F. 78
14	C. 68	C. 72	C. 70	C. 74	C. 85	C. 72	C. 76	F. 84	F. 73	F. 80	F. 94	C. 72

Aug., 1857.	Alexandria, Va.			All Saints, S. C.			Warrington, Fla.			Austin, Tex.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	F. 73	C. 83	C. 74	C. 75	C. 78	C. 76	C. 79	C. 83	C. 78	C. 76	C. 96	C. 82
2	F. 75	F. 84	F. 71	C. 76	R. 81	R. 74	C. 76	C. 83	C. 79	C. 74	C. 92	C. 75
3	F. 73	F. 83	F. 75	C. 75	C 75	C. 78	C. 73	C. 74	C. 78	C. 75	C. 88	C. 74
4	C. 74	C. 79	C. 75	C. 77	C. 78	C. 79	C. 81	C. 83	C. 80	C. 74	C. 92	F. 80
5	C. 71	C. 75	C. 71	C. 76	C. 80	C. 79	C. 76	C. 80	C. 77	F. 74	F. 94	F. 82
6	F. 71	C. 83	C. 74	C. 77	R. 79	C. 77	C. 76	C. 82	C. 78	F. 77	C. 93	F. 83
7	F. 74	C. 82	F. 73	C. 74	C. 78	F. 77	C. 80	C. 82	R. 79	C. 76	C. 94	F. 84
8	C. 71	F. 81	C. 74	F. 74	F. 79	F. 78	C. 76	C. 77	C. 79	F. 78	C. 94	F. 84
9	C. 75	C. 88	F. 76	F. 75	R. 77	C. 77	C. 79	F. 82	F. 80	F. 82	C. 94	F. 85
10	C. 76	C. 81	C. 77	F. 78	R. 81	C. 79	C. 79	F. 82	F. 79	F. 81	C. 94	F. 76
11	C. 76	F. 84	F. 74	C. 78	C. 80	F. 81	C. 80	C. 85	F. 79	C. 78	C. 92	F. 80
12	F. 77	F. 86	F. 76	F. 76	F. 82	F. 80	F. 82	F. 84	F. 80	C. 76	C. 94	F. 81
13	C. 80	F. 85	F. 82	F. 77	F. 83	F. 80	F. 82	F. 85	F. 80	C. 76	C. 88	C. 80
14	F. 81	C. 91	F. 87	F. 79	F. 83	F. 81	F. 81	F. 85	F. 80	C. 77	C. 90	F. 81

Aug., 1857.	Glenwood, Tenn.			Hillsboro', Ohio.			Platteville, Wis.			San Francisco, Cal.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	C. 71	C. 84	F. 76	F. 68	C. 80	F. 70	F. 72	F. 88	F. 74	C. 58	F. 64	C. 56
2	C. 72	C. 78	C. 75	F. 66	F. 80	F. 71	F. 73	F. 92	F. 79	C. 56	F. 64	C. 54
3	C. 72	R. 76	C. 74	F. 64	F. 80	F. 69	F. 76	R. 76	C. 71	F. 58	F. 65	F. 55
4	C. 73	R. 77	F. 74	C. 69	C. 80	C. 70	C. 70	F. 85	F. 67	C. 57	F. 67	F. 56
5	C. 72	C. 81	F. 71	C. 67	F. 76	F. 69	C. 64	C. 83	F. 70	F. 57	F. 68	F. 54
6	F. 66	F. 82	F. 74	F. 63	F. 79	F. 71	C. 65	C. 75	C. 72	F. 57	F. 68	F. 55
7	F. 72	C. 84	F. 77	F. 66	F. 81	F. 73	C. 72	C. 85	C. 78	F. 58	F. 72	F. 58
8	F. 73	C. 84	C. 77	F. 71	C. 80	C. 74	F. 71	F. 90	F. 74	F. 59	F. 83	F. 66
9	F. 75	C. 81	F. 72	C. 72	C. 81	C. 70	F. 70	C. 90	F. 76	F. 66	F. 97	F. 64
10	C. 73	C. 75	F. 73	C. 69	C. 70	F. 70	F. 86	F. 88	F. 73	C. 57	C. 70	C. 58
11	C. 72	C. 84	F. 76	F. 66	F. 79	F. 73	C. 74	F. 89	C. 79	C. 58	F. 66	F. 54
12	F. 74	C. 84	F. 79	F. 68	F. 83	F. 75	F. 76	F. 96	F. 82	F. 56	F. 69	F. 55
13	F. 78	C. 85	F. 78	F. 73	F. 83	F. 76	F. 82	F. 99	C. 78	C. 56	F. 63	F. 54
14	F. 77	C. 87	F. 79	F. 75	F. 85	F. 77	C. 70	C. 76	F. 68	F. 56	F. 69	F. 56

15	F. 65 F. 69 C. 68	C. 67 F. 72 F. 62	F. 76 C. 81 F. 71	C. 74 F. 76 F. 62	F. 82 C. 88 C. 80	F. 78 F. 84 F. 82	F. 83 C. 88 F. 80	C. 75 C. 90 F. 78	F. 77 C. 87 F. 77	F. 73 F. 83 F. 72	F. 65 C. 75 C. 66	C. 56 F. 66 C. 53
16	F. 62 F. 66 F. 56	F. 62 F. 70 F. 62	F. 70 F. 72 F. 62	F. 64 F. 74 C. 62	C. 76 C. 73 C. 73	F. 81 F. 84 F. 82	F. 81 F. 85 F. 80	C. 76 C. 94 F. 82	C. 75 C. 86 F. 78	? 71 F. 83 F. 77	R. 64 R. 68 C. 60	C. 53 F. 64 C. 53
17	F. 52 F. 67 C. 61	C. 56 C. 63 F. 59	C. 71 C. 69 C. 68	F. 64 C. 65 C. 66	C. 76 F. 81 F. 79	F. 81 F. 83 F. 80	F. 80 F. 85 F. 80	F. 76 C. 94 F. 82	F. 75 C. 87 R. 74	F. 74 C. 78 ? 70	C. 59 C. 76 F. 67	F. 53 F. 64 C. 53
18	C. 59 C. 79 C. 68	F. 57 C. 68 F. 62	C. 67 C. 70 F. 61	C. 58 F. 70 F. 54	F. 79 C. 76 F. 70	F. 79 ? 84 F. 81	F. 83 F. 89 F. 82	C. 75 C. 95 F. 84	C. 71 C. 72 C. 67	C. 66 C. 69 F. 53	F. 59 F. 76 F. 65	C. 55 C. 63 C. 56
19	F. 58 F. 73 F. 63	F. 63 R. 73 C. 61	F. 64 F. 71 F. 60	F. 60 R. 73 C. 59	F. 71 C. 79 F. 76	F. 79 F. 82 C. 78	F. 84 C. 88 C. 81	F. 77 C. 94 F. 84	C. 66 C. 74 C. 69	F. 61 F. 73 F. 64	C. 58 F. 74 F. 64	C. 55 F. 66 F. 54
20	F. 60 C. 65 C. 65	C. 60 C. 68 C. 61	F. 60 C. 70 F. 58	F. 62 F. 72 F. 58	C. 68 F. 77 F. 67	C. 74 R. 73 R. 72	C. 78 C. 76 F. 78	C. 76 C. 94 F. 84	F. 64 F. 78 F. 67	F. 58 ? 70 C. 59	C. 62 C. 68 C. 64	F. 56 F. 65 C. 53
21	F. 61 F. 70 F. 64	C. 61 C. 66 F. 62	F. 62 C. 70 F. 61	F. 61 F. 74 F. 60	F. 68 F. 77 F. 71	C. 67 C. 77 F. 75	F. 73 F. 82 F. 78	C. 79 C. 90 F. 79	F. 62 F. 78 F. 69	F. 58 C. 71 ? 63	C. 66 C. 78 C. 69	C. 55 F. 65 C. 53
22	F. 65 F. 73 F. 63	C. 61 C. 70 C. 63	C. 60 C. 68 C. 62	F. 64 C. 68 R. 62	F. 66 E. 77 C. 38	F. 68 F. 80 F. 76	F. 77 F. 81 F. 78	F. 76 C. 91 F. 80	C. 67 C. 78 F. 67	F. 62 F. 75 F. 65	C. 64 C. 73 F. 61	C. 56 F. 66 C. 53
23	C. 63 C. 67 C. 65	C. 61 C. 65 C. 63	C. 66 C. 75 C. 62	F. 66 C. 71 C. 59	F. 69 F. 79 F. 69	F. 71 F. 81 F. 77	F. 79 F. 84 F. 80	F. 77 C. 90 F. 83	F. 62 C. 74 C. 67	F. 57 F. 69 ? 62	F. 56 F. 75 F. 65	C. 56 F. 65 C. 55
24	C. 65 C. 70 C. 65	C. 56 C. 63 F. 58	F. 65 F. 72 F. 64	F. 55 F. 68 F. 60	F. 68 C. 74 F. 65	F. 73 F. 80 F. 79	F. 81 F. 85 F. 79	C. 76 C. 95 F. 86	C. 64 R. 72 C. 66	C. 56 C. 68 F. 60	F. 60 F. 78 F. 66	C. 56 F. 65 C. 55
25	C. 65 ? 70 F. 57	F. 59 F. 72 F. 65	F. 64 F. 73 F. 64	F. 65 F. 78 F. 68	F. 60 F. 75 F. 68	F. 79 C. 81 C. 79	F. 80 F. 84 F. 79	C. 80 C. 93 F. 84	C. 65 C. 66 C. 67	F. 57 F. 72 ? 66	F. 61 F. 81 F. 70	C. 57 C. 63 C. 55
26	F. 54 F. 78 F. 54	F. 66 F. 78 F. 67	F. 69 F. 74 F. 65	F. 70 F. 80 F. 66	C. 67 C. 79 C. 72	C. 79 C. 83 C. 80	F. 81 F. 84 F. 80	C. 78 C. 94 F. 86	C. 68 C. 73 O. 71	C. 65 C. 72 ? 66	C. 69 C. 84 C. 72	C. 56 F. 65 C. 55
27	F. 63 F. 82 F. 74	F. 67 F. 79 C. 71	F. 68 F. 75 F. 66	F. 70 F. 76 C. 68	R. 71 R. 71 R. 71	C. 81 F. 84 F. 80	F. 80 F. 85 F. 80	F. 76 F. 95 F. 86	C. 71 C. 77 F. 71	C. 67 C. 71 C. 70	C. 70 R. 77 F. 65	C. 55 C. 62 C. 56
28	F. 69 F. 79 C. 72	C. 65 F. 75 C. 69	C. 68 C. 66 R. 67	R. 60 C. 79 F. 63	F. 74 C. 82 C. 72	F. 78 F. 88 C. 84	F. 82 F. 84 C. 79	F. 79 F. 97 C. 80	C. 70 F. 78 C. 70	F. 63 F. 74 F. 67	F. 61 C. 75 F. 60	C. 56 F. 65 F. 56
29	C. 64 C. 80 C. 74	C. 67 R. 67 C. 64	C. 68 C. 74 C. 66	C. 68 F. 74 F. 59	?	C. 76 F. 85 F. 82	F. 78 F. 86 F. 80	C. 76 C. 92 C. 82	F. 61 C. 71 F. 62	F. 56 ? 67 ? 58	F. 55 F. 72 F. 58	C. 56 F. 70 F. 56
30	C. 74 C. 74 C. 74	F. 62 C. 66 C. 62	F. 68 F. 73 F. 64	F. 55 F. 69 F. 57	?	F. 72 F. 81 F. 79	F. 76 F. 83 F. 78	F. 70 F. 90 F. 81	F. 58 C. 72 F. 63	F. 52 F. 68 F. 58	F. 54 F. 85 F. 68	C. 56 F. 65 C. 56
31	F. 60 F. 64 C. 60	C. 62 C. 65 F. 57	F. 65 F. 73 F. 65	F. 62 F. 72 F. 60	?	F. 75 F. 80 F. 78	F. 78 F. 82 F. 79	C. 74 C. 88 C. 79	F. 56 C. 76 F. 66	F. 55 ? 72 F. 61	F. 62 F. 86 F. 71	C. 55 C. 65 C. 54

Register of the temperature and face of the sky, &c.—Continued.

Sept. 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.			Alexandria, Va.			All Saints, S. C.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	F. 66	F. 68	F. 55	F. 59	F. 78	F. 73	F. 68	F. 71	F. 60	? 62	? 80	? 68		?		F. 74	F. 80	F. 76
2	F. 58	F. 78	F. 61	F. 65	F. 81	F. 74	F. 65	F. 75	F. 60	? 65	? 82	F. 69	C. 68	F. 77	F. 70	F. 70	C. 80	C. 79
3	F. 66	F. 83	F. 64	C. 78	F. 80	F. 73	F. 65	F. 80	F. 64	? 66	? 85	? 71	C. 69	F. 81	F. 75	F. 71	C. 81	F. 79
4	F. 66	F. 82	F. 74	F. 65	F. 81	C. 71	F. 68	F. 81	F. 68	? 66	C. 80	F. 70	C. 71	C. 82	F. 74	R. 74	C. 81	C. 79
5	F. 64	C. 73	F. 68	F. 72	F. 81	R. 69	C. 70	C. 75	F. 68	? 67	C. 80	C. 69	C. 70	F. 78	F. 72	F. 74	F. 82	F. 79
6	C. 71	C. 67	F. 63	F. 59	C. 62	F. 54	C. 69	C. 62	F. 64	R. 57	R. 60	R. 59	F. 70	C. 78	F. 69	F. 74	F. 81	F. 80
7	F. 50	F. 71	F. 65	F. 54	F. 59	F. 52	F. 60	F. 63	F. 58	? 53	? 66	? 55	F. 60	F. 69	F. 60	C. 73	C. 81	F. 73
8	F. 47	F. 61	F. 50	C. 50	C. 65	C. 60	F. 60	F. 70	F. 56	? 50	? 74	? 59	F. 54	F. 69	F. 60	F. 64	F. 76	C. 74
9	R. 55	C. 62	F. 57	R. 57	C. 68	C. 63	F. 64	F. 70	F. 62	? 56	? 77	? 65	F. 54	F. 71	F. 62	F. 66	F. 78	F. 77
10	F. 49	C. 64	C. 62	C. 62	C. 80	F. 74	F. 65	F. 72	F. 66	F. 66	F. 83	? 74	F. 61	F. 71	F. 63	F. 66	F. 81	F. 78
11	F. 69	C. 70	F. 59	F. 71	C. 60	F. 57	F. 68	F. 73	F. 67	? 72	F. 88	F. 71	C. 68	F. 78	F. 67	C. 73	R. 82	R. 77
12	F. 50	F. 60	C. 55	C. 51	C. 56	C. 54	C. 65	F. 67	F. 60	C. 66	F. 78	? 68	C. 66	C. 81	C. 69	C. 75	C. 77	C. 74
13	C. 57	C. 63	C. 54	FOG. 55	F. 74	F. 68	C. 65	C. 69	C. 65	? 69	C. 88	? 75	C. 71	C. 77	C. 74	C. 74	C. 81	F. 80
14	C. 59	C. 68	C. 62	C. 67	C. 65	R. 68	C. 68	C. 76	C. 70	F. 69	C. 77	C. 72	C. 73	F. 81	F. 71	F. 76	F. 83	F. 79

Sept. 1857.	Warrington, Fla.			Austin, Tex.			Glenwood, Tenn.			Hillsboro', Ohio.			Platteville, Wis.			San Francisco, Cal.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	F. 78	F. 81	F. 77	C. 74	C. 91	F. 80	F. 63	C. 80	F. 71	F. 59	F. 76	F. 65	F. 62	F. 85	F. 72	C 58	F. 67	C. 51
2	C. 75	C. 76	C. 76	C. 73	C. 92	C. 79	F. 67	C. 80	F. 70	F. 61	F. 76	? 65	F. 64	F. 89	F. 72	C. 58	F. 65	C. 56
3	C. 75	C. 77	C. 76	C. 76	F. 94	C. 85	C. 65	C. 74	C. 71	C. 61	C. 79	F. 65	F. 69	C. 88	C. 74	C. 58	F. 64	F. 54
4	F. 76	F. 79	F. 80	C. 76	F. 94	C. 84	C. 68	C. 80	F. 72	? ?	C. 78	F. 69	C. 74	C. 90	C. 73	C. 55	F. 64	C. 55
5	F. 77	F. 84	F. 81	F. 77	F. 90	F. 84	F. 69	C. 82	F. 72	C. 67	F. 79	C. 72	C. 63	C. 75	C. 58	C. 54	F. 63	F. 54
6	F. 79	F. 84	F. 79	C. 78	C. 80	C. 75	C. 68	C. 80	F. 70	C. 65	C. 66	F. 64	F. 54	F. 76	F. 58	C. 57	F. 65	F. 56
7	F. 79	F. 85	F. 80	C. 74	R. 77	C. 74	C. 69	C. 75	F. 68	F. 53	F. 68	F. 58	C. 60	F. 77	C. 64	C. 59	F. 65	C. 56
8	F. 82	F. 84	F. 81	C. 72	C. 80	F. 75	C. 66	C. 78	F. 73	F. 54	F. 75	F. 66	C. 59	F. 80	F. 72	C. 57	F. 64	F. 58
9	F. 79	F. 82	F. 78	C. 73	C. 80	F. 74	C. 70	C. 78	F. 72	F 62	F. 77	? 69	F. 69	F. 90	F. 78	F. 59	F. 65	F. 56
10	F. 79	F. 81	F. 78	C. 72	C. 82	C. 75	F. 69	F. 81	F. 71	? 67	? 79	? 70	F. 74	F. 89	F. 77	C. 59	F. 66	F. 58
11	F. 75	F. 81	F. 78	C. 75	F. 86	F. 76	F. 68	F. 81	F. 69	F. 67	F. 78	? 71	F. 74	F. 88	F. 75	F. 59	F. 69	F. 58
12	F. 75	F. 82	F. 78	C. 76	C. 88	F. 76	F. 62	C. 80	F. 69	F. 66	F. 81	F. 70	C. 71	C. 85	C. 70	C. 62	F. 86	F. 66
13	F. 76	F. 84	F. 80	C. 71	C. 85	C. 76	F. 65	C. 82	F. 73	F. 67	F. 81	? 71	C. 67	C. 78	F. 68	F. 66	F. 80	F. 66
14	F. 78	F. 84	F. 78	C. 76	C. 77	C. 73	F. 67	C. 80	F. 72	F. 68	C. 77	F. 70	F. 60	F. 76	F. 60	F. 69	F. 69	F. 60

15	R. 68 F. 75 F. 64	C. 61 C. 67 F. 57	C. 70 F. 74 F. 66	? 59 C. 76 ? 60	F. 72 F. 81 F. 74	F. 75 F. 83 F. 81	F. 79 C. 83 F. 79	C. 74 C. 86 F. 78	F. 70 C. 81 F. 74	F. 60 F. 74 F. 63	F. 56 C. 76 C. 64	C. 59 C. 63 C. 59
16	F. 55 F. 58 F. 51	F. 51 C. 61 F. 56	F. 61 F. 66 F. 62	C. 53 C. 68 C. 59	C. 60 C. 75 C. 72	F. 81 C. 80 C. 80	F. 82 F. 86 F. 80	C. 76 F. 87 C. 74	F. 69 F. 85 F. 75	F. 56 C. 78 F. 71	R. 62 R. 76 R. 76	C. 59 C. 65 F. 59
17	F. 49 F. 63 C. 54	C. 55 R. 56 C. 55	F. 62 C. 67 C. 67	C. 59 C. 76 C. 64	F. 72 F. 84 F. 72	F. 78 F. 82 F. 79	F. 85 F. 87 F. 81	C. 75 F. 90 F. 80	C. 71 F. 86 F. 77	F. 70 F. 82 F. 70	R. 72 R. 76 R. 63	C. 60 F. 68 F. 58
18	C. 56 F. 59 F. 50	F. 49 C. 56 F. 48	F. 67 F. 72 F. 68	C. 55 C. 56 ? 52	C. 71 F. 83 C. 75	C. 75 F. 84 F. 80	F. 82 F. 86 F. 81	C. 76 C. 80 F. 76	F. 72 C. 85 C. 74	F. 68 F. 80 C. 70	R. 56 R. 58 R. 54	F. 59 F. 68 F. 58
19	F. 46 F. 54 F. 46	F. 45 C. 54 F. 50	F. 58 C. 61 C. 53	R. 49 R. 51 C. 51	C. 65 C. 62 C. 60	C. 77 F. 83 F. 79	F. 82 F. 85 F. 80	C. 74 C. 75 F. 72	C. 70 C. 80 C. 68	C. 68 F. 76 C. 65	R. 52 R. 59 F. 53	F. 59 F. 64 F. 59
20	C. 46 C. 60 C. 49	C. 48 C. 50 C. 48	C. 58 C. 62 C. 57	C. 51 C. 53 C. 53	C. 60 C. 73 C. 62	F. 78 F. 83 C. 78	F. 79 F. 84 F. 79	C. 70 F. 82 F. 72	C. 60 C. 64 C. 60	C. 55 C. 58 C. 53	F. 50 F. 57 C. 52	F. 59 F. 67 F. 55
21	C. 51 C. 57 C. 53	? 45 C. 53 F. 50	C. 57 C. 61 C. 56	F. 48 C. 60 C. 54	F. 60 C. 75 C. 62	C. 72 C. 80 C. 76	F. 75 F. 81 F. 78	C. 68 C. 85 R 76	F. 55 C. 66 F. 57	C. 52 C. 61 F. 54	C. 50 C. 58 F. 54	C. 59 F. 66 C. 55
22	F. 50 C. 61 C. 53	C. 51 C. 56 R. 51	C. 56 C. 60 C. 58	C. 52 C. 59 C. 54	R. 63 R. 73 R. 64	C. 73 F. 79 C. 74	C. 75 F. 91 F. 70	R. 64 F. 73 F. 65	F. 56 C. 62 F. 53	C. 52 C. 59 F. 52	C. 50 F. 56 F. 48	C. 57 F. 64 F. 57
23	C. 61 R. 71 R. 49	C. 46 C. 56 C. 47	C. 60 C. 65 F. 57	C. 45 C. 55 ? 49	R. 62 R. 67 R. 53	C. 65 F. 73 F. 67	F. 64 F. 80 F. 69	F. 58 F. 76 F. 66	F. 47 F. 68 F. 54	F. 46 F. 60 F. 51	F. 48 F. 70 F. 60	C. 59 F. 66 C. 57
24	F. 48 F. 58 F. 52	F. 52 F. 62 F. 56	F. 56 F. 65 F. 57	? 49 ? 73 ? 58	F. 48 F. 67 F. 56	F. 62 C. 74 F. 69	F. 63 F. 79 F. 70	F. 60 F. 80 F. 70	F. 46 F. 72 F. 58	F. 43 F. 63 F. 60	F. 58 F. 80 F. 67	F. 57 F. 72 F. 57
25	F. 47 F. 72 F. 56	F. 55 F. 73 F. 61	C. 58 C. 75 C. 60	? 55 ? 77 ? 63	C. 51 F. 70 F. 57	C. 63 C. 73 C. 68	F. 70 F. 81 F. 72	F. 60 F. 82 F. 72	F. 50 F. 75 F. 60	F. 54 F. 70 F. 63	F. 62 F. 78 F. 62	C. 60 F. 69 F. 59
26	F. 51 F. 73 F. 58	F. 61 F. 69 F. 62	C. 69 F. 71 F. 61	? 59 ? 72 ? 64	F. 56 F. 78 F. 65	F. 65 C. 75 C. 74	F. 73 F. 81 F. 73	F. 64 F. 82 F. 70	F. 51 F. 76 F. 61	F. 54 F. 70 F. 67	F. 60 F. 82 F. 70	F. 60 F. 76 F. 63
27	F. 55 F. 70 F. 56	F. 59 F. 75 F. 65	F. 65 F. 71 F. 61	C. 61 F. 78 ? 67	F. 59 F. 75 F. 66	C. 71 C. 77 F. 73	C. 73 F. 80 F. 76	F. 64 F. 82 F. 75	F. 53 F. 78 F. 62	F. 58 F. 70 F. 67	C. 62 C. 70 C. 62	F. 64 F. 92 F. 77
28	F. 54 F. 74 F. 65	C. 60 C. 54 C. 51	F. 64 F. 71 C. 62	C. 55 C. 66 C. 53	F. 56 F. 77 F. 65	C. 71 C. 77 F. 75	F. 76 F. 81 F. 79	C. 70 F. 84 F. 75	F. 56 F. 73 F. 56	F. 58 F. 66 F. 56	F. 48 C. 56 F. 45	F. 72 F. 80 F. 57
29	F. 53 F. 60 F. 46	F. 41 C. 47 F. 40	F. 58 F. 62 F. 53	F. 43 C. 51 C. 44	F. 55 C. 61 C. 54	F. 68 F. 76 F. 70	F. 76 F. 90 F. 72	C. 68 C. 52 C. 75	F. 47 F. 65 F. 48	F. 41 C. 54 F. 50	F. 42 F. 55 F. 45	C. 62 F. 72 F. 57
30	F. 41 F. 47 F. 42	C. 41 C. 51 C. 42	F. 50 F. 57 C. 50	C. 40 C. 55 C. 45	F. 48 F. 60 F. 48	F. 54 F. 68 F. 59	F. 67 F. 81 F. 74	C. 69 F. 83 C. 77	F. 42 F. 68 F. 54	F. 41 F. 58 F. 53	F. 38 C. 63 C. 56	C. 57 F. 61 C. 54

Register of the temperature and face of the sky, &c.—Continued.

Oct., 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.			Alexandria, Va.			All Saints, S. C.			Warrington, Fla.			Austin, Tex.			Glenwood, Tenn.			Hillsboro', Ohio.			Platteville, Wis.			San Francisco, Cal.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	F. 40	F. 55	F. 45	C. 41	C. 59	C. 44	F. 52	F. 61	C. 56	C. 44	R. 51	R. 50	F. 41	F. 65	C. 57	F. 58	F. 71	F. 70	C. 67	C. 72	C. 70	C. 72	C. 84	C. 73	F. 49	F. 73	F. 64	C. 54	F. 65	C. 59	R. 59	R. 69	R. 57	C. 55	F. 62	F. 54
2	C. 51	C. 57	C. 55	F. 36	F. 47	F. 43	C. 62	C. 69	C. 59	C. 47	R. 47	C. 48	F. 59	F. 69	C. 63	F. 64	F. 76	C. 74	F. 66	F. 78	F. 70	C. 73	C. 86	C. 78	R. 57	F. 65	C. 61	C. 55	C. 55	C. 52	C. 53	C. 55	C. 49	F. 56	C. 59	C. 56
3	C. 50	C. 50	C. 49	F. 39	F. 42	F. 46	F. 59	C. 57	C. 53	C. 50	C. 55	C. 53	C. 63	C. 72	F. 63	C. 68	C. 77	F. 67	F. 71	F. 79	F. 73	C. 76	C. 89	F. 80	C. 54	C. 65	C. 56	C. 52	C. 58	F. 54	C. 50	C. 56	C. 52	C. 57	F. 65	C. 60
4	F. 50	C. 58	F. 49	F. 39	F. 45	F. 51	C. 57	C. 57	F. 53	C. 53	C. 62	? 55	C. 57	C. 66	F. 56	F. 64	C. 73	F. 64	F. 74	F. 79	F. 76	F. 77	R. 69	C. 70	C. 54	F. 73	C. 61	F. 50	F. 64	F. 60	C. 53	C. 64	? ?	C. 60	F. 68	C. 61
5	F. 42	F. 59	F. 45	F. 46	F. 61	F. 52	F. 50	F. 56	F. 53	C. 51	C. 58	F. 50	F. 52	C. 70	F. 59	F. 57	F. 73	F. 63	F. 76	F. 78	F. 74	C. 69	F. 81	C. 75	C. 58	C. 67	R. 63	F. 49	C. 66	F. 56	C. 55	C. 69	F. 58	C. 60	C. 65	C. 60
6	F. 39	F. 56	F. 48	C. 49	C. 61	F. 53	F. 56	F. 60	F. 54	FOG. 51	F. 63	? 54	F. 52	F. 68	C. 54	F. 55	C. 71	F. 62	C. 72	C. 71	C. 69	F. 68	C. 78	F. 70	C. 60	C. 70	C. 61	F. 50	F. 65	F. 55	FOG. 54	F. 70	? ?	C. 56	C. 60	C. 58
7	F. 46	C. 58	F. 51	F. 50	F. 58	F. 51	F. 57	F. 59	F. 53	45	? 59	49	F. 50	F. 68	F. 53	C. 56	C. 68	C. 68	C. 66	C. 70	C. 70	C. 66	F. 76	F. 69	C. 57	C. 67	C. 58	C. 50	C. 55	F. 51	FOG. 52	F. 67	F. 52	C. 59	F. 65	C. 60
8	C. 47	F. 61	C. 55	F. 49	F. 63	F. 57	C. 58	F. 65	F. 58	44	? 67	54	C. 49	F. 70	F. 52	C. 62	C. 71	C. 71	C. 67	C. 72	C. 68	F. 67	C. 79	F. 70	C. 52	C. 70	F. 59	F. 47	F. 63	F. 55	FOG. 50	F. 68	F. 53	C. 57	C. 60	F. 57
9	F. 46	C. 60	F. 46	F. 46	F. 54	F. 46	F. 59	F. 61	F. 52	FOG. 48	C. 60	? 52	C. 48	F. 67	F. 55	R. 67	R. 67	C. 65	F. 65	F. 80	F. 73	F. 63	C. 79	F. 72	C. 58	C. 70	F. 60	F. 51	C. 65	F. 59	F. 48	C. 70	F. 59	F. 56	F. 67	F. 56
10	F. 46	F. 58	F. 39	F. 40	F. 56	F. 47	F. 55	C. 58	F. 51	44	? 60	53	C. 58	C. 67	F. 57	C. 66	R. 70	C. 69	F. 70	F. 79	F. 71	R. 70	R. 72	R. 72	F. 53	F. 73	F. 60	F. 47	F. 65	F. 61	F. 53	F. 71	F. 58	F. 57	F. 73	F. 60
11	F. 36	F. 60	F. 50	F. 42	F. 62	F. 49	F. 56	F. 62	F. 53	47	? 63	54	C. 55	C. 65	C. 62	C. 67	R. 68	C. 70	F. 69	F. 72	F. 70	R. 65	F. 75	F. 67	C. 57	C. 72	F. 67	C. 60	C. 67	? ?	C. 60	C. 67	? ?	F. 57	F. 71	F. 58
12	F. 45	F. 66	F. 55	FOG. 46	C. 63	C. 58	C. 55	F. 72	F. 61	C. 53	C. 72	C. 63	C. 60	F. 70	F. 64	C. 71	F. 75	C. 73	C. 69	C. 74	F. 72	F. 61	F. 80	F. 67	C. 64	C. 71	C. 67	C. 61	C. 65	C. 63	F. 49	F. 63	F. 55	F. 57	F. 75	F. 61
13	C. 55	F. 73	F. 62	? 57	C. 65	F. 53	F. 58	F. 74	F. 61	C. 61	C. 58	F. 54	C. 62	F. 73	F. 66	C. 72	C. 76	C. 76	C. 72	C. 79	F. 76	F. 64	C. 79	F. 69	R. 65	R. 69	R. 62	C. 59	C. 63	F. 58	F. 40	F. 59	? ?	F. 60	F. 80	F. 67
14	C. 59	C. 61	C. 58	? 46	C. 56	F. 51	R. 65	R. 64	R. 63	C. 51	C. 59	C. 55	C. 65	C. 74	C. 68	R. 72	C. 75	? 72	C. 74	F. 81	F. 76	F. 59	F. 78	F. 65	R. 57	C. 62	F. 51	C. 50	C. 53	C. 54	F. 41	F. 66	? ?	F. 60	F. 85	F. 69

15	C. 58	C. 67	C. 62	? 47	C. 51	C. 48	C. 59	C. 68	R. 64	R. 51	R. 52	R. 49	C. 65	C. 70	F. 61	C. 71	F. 75	F. 69	F. 70	F. 86	F. 76	C. 58	C. 77	C. 66	F. 46	C. 69	C. 48	F. 47	F. 59	C. 51	F. 42	C. 43	C. 42	F. 61	F. 85	F. 75
16	C. 68	C. 74	C. 67	R. 48	C. 51	C. 46	C. 63	F. 68	F. 62	R. 48	R. 43	C. 49	C. 57	C. 54	F. 52	F. 60	F. 65	F. 54	F. 58	F. 75	F. 59	C. 53	F. 67	F. 52	C. 45	C. 55	F. 45	C. 47	C. 50	F. 50	F. 40	F. 53	F. 45	F. 65	C. 75	C. 56
17	C. 63	C. 62	F. 49	C. 42	F. 45	C. 41	F. 53	F. 56	F. 51	C. 39	R. 51	R. 49	F. 48	F. 62	F. 51	F. 49	F. 65	F. 56	F. 59	F. 73	F. 59	F. 45	F. 73	F. 64	F. 39	C. 61	C. 50	F. 45	F. 53	F. 49	F. 38	C. 50	F. 42	C. 56	F. 65	F. 56
18	F. 42	C. 56	F. 46	F. 44	C. 50	F. 42	F. 58	F. 63	F. 54	F. 42	C. 53	C. 48	C. 49	C. 65	F. 52	F. 54	F. 70	F. 69	F. 58	F. 75	F. 69	C. 60	C. 77	F. 69	C. 49	C. 64	C. 57	C. 47	F. 55	C. 53	C. 41	C. 40	? ?	C. 56	F. 63	F. 57
19	C. 40	C. 56	C. 54	C. 44	R. 51	C. 47	F. 55	C. 62	C. 61	C. 52	R. 50	R. 45	C. 58	C. 68	F. 66	F. 69	C. 75	C. 68	F. 69	F. 77	F. 70	C. 64	C. 72	C. 51	R. 56	R. 56	C. 46	C. 53	C. 54	F. 49	C. 35	C. 39	? 30	F. 55	F. 68	F. 55
20	C. 59	C. 52	F. 42	R. 40	R. 37	C. 36	R. 54	F. 52	C. 42	C. 34	C. 39	F. 36	C. 49	F. 48	F. 39	F. 64	F. 73	F. 56	F. 66	F. 78	F. 60	C. 54	C. 68	C. 60	35	? 48	35	F. 35	F. 42	F. 35	F. 23	F. 43	F. 31	F. 55	F. 63	F. 55
21	C. 39	C. 41	C. 37	C. 34	C. 39	F. 33	C. 40	C. 45	C. 42	C. 32	R. 39	R. 35	F. 34	F. 50	F. 41	F. 43	F. 57	F. 48	F. 56	F. 73	F. 66	C. 59	C. 67	C. 55	F. 31	F. 54	F. 46	F. 32	F. 46	F. 39	F. 31	? 56	C. 46	F. 54	F. 64	F. 55
22	F. 31	F. 38	F. 35	F. 30	F. 40	F. 35	F. 38	F. 44	F. 43	? 30	? 49	F. 43	F. 32	C. 55	F. 45	F. 46	C. 57	F. 48	F. 66	F. 71	F. 70	C. 56	C. 59	C. 58	C. 45	C. 60	C. 55	C. 41	C. 50	C. 45	C. 40	C. 47	C. 41	C. 57	F. 62	F. 55
23	F. 27	F. 39	F. 37	C. 33	C. 51	F. 48	F. 40	C. 51	C. 48	C. 40	C. 51	C. 47	C. 46	C. 56	C. 50	C. 50	C. 66	C. 62	R. 69	R. 71	C. 70	C. 58	C. 68	C. 63	C. 52	C. 55	C. 54	C. 48	C. 55	C. 52	C. 42	C. 47	? ?	C. 57	F. 67	F. 52
24	C. 44	C. 55	F. 44	? 39	C. 49	C. 46	C. 50	C. 57	C. 51	C. 46	C. 52	C. 49	C. 50	C. 59	C. 56	60	? 66	64	C. 71	F. 81	F. 70	C. 63	C. 65	C. 63	R. 52	C. 63	R. 55	C. 50	C. 55	F. 52	C. 47	C. 54	C 50	C. 52	C. 59	C. 56
25	F. 36	F. 57	C. 50	C. 46	C. 47	C. 47	C. 54	C. 55	C. 56	C. 47	C. 52	C. 49	C. 55	C. 58	C. 55	C. 60	R. 68	R. 55	F. 65	F. 77	F. 71	C. 61	C. 67	F. 63	C. 47	F. 56	C. 43	C. 48	C. 48	C. 45	C. 40	F. 51	? 30	C. 58	C. 62	F. 57
26	C. 55	C. 64	C. 61	C. 46	C. 48	C. 46	R. 57	F. 64	F. 55	C. 44	C. 43	C. 38	C. 57	C. 53	C. 51	C. 49	C. 64	F. 53	F. 56	F. 76	F. 60	C. 62	C. 69	C. 67	F. 37	F. 56	F. 41	C. 43	F. 48	F. 40	F. 30	C. 50	C. 42	C. 57	C. 63	F. 57
27	C. 52	C. 48	C. 40	C. 37	C. 40	C. 35	C. 53	C. 55	R. 51	C. 37	C. 41	C. 41	C. 48	C. 53	C. 48	F. 48	F. 67	F. 57	F. 56	F. 71	F. 56	C. 64	C. 74	C. 61	F. 34	F. 59	F. 50	C. 32	F. 46	F. 40	C. 40	C. 46	C. 43	F. 56	F. 64	F. 58
28	C. 48	C. 48	C. 48	C. 31	C. 31	C. 33	C. 44	C. 45	R. 44	C. 39	C. 39	C. 37	C. 41	C. 48	C. 44	F. 45	F. 62	C. 54	F. 60	F. 78	F. 61	F. 56	F. 68	C. 55	F. 48	F. 51	C. 39	C. 33	C. 44	C. 40	C. 45	? ?	C. 40	F. 58	F. 71	F. 64
29	C. 50	C. 53	C. 46	C. 35	C. 39	C. 37	R. 45	C. 50	C. 46	C. 35	C. 41	C. 38	C. 43	C. 53	F. 47	F. 46	C. 61	F. 52	C. 56	F. 60	F. 56	C. 57	C. 65	F. 61	C. 33	C. 51	F. 46	C. 40	C. 45	C. 41	C. 49	C. 55	C. 40	F. 59	F. 76	F. 61
30	C. 45	C. 44	C. 42	C. 36	C. 42	C 40	C. 44	F. 51	C. 46	F. 32	C. 46	C. 43	C. 41	C. 57	C. 45	F. 49	F. 59	F. 51	F. 51	F. 62	F. 56	F. 53	F. 73	F. 52	F. 43	C. 52	C. 40	C. 37	C. 44	C. 41	F. 39	F. 43	F. 45	F. 59	F. 78	F. 70
31	C. 40	F. 49	C. 43	C. 40	C. 45	C. 43	C. 45	C. 50	C. 47	C. 40	C. 48	C. 43	C. 41	F. 57	F. 40	C. 46	F. 63	F. 50	F. 60	F. 76	F. 60	F. 52	F. 73	F. 57	C. 43	C. 52	F. 40	C. 36	C. 48	C. 44	C. 45	C. 48	C. 42	F. 59	C. 71	F. 54

Register of the temperature and face of the sky, &c.—Continued.

Nov., 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.			Alexandria, Va.			All Saints, S. C.		
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.
1	C. 43	C. 46	C. 42	C. 41	R. 45	C. 42	C. 48	C. 54	C. 50	C. 40	C. 47	C. 46	F. 42	F. 57	F. 44	F. 47	C. 57	F. 48
2	F. 40	F. 48	F. 46	C. 45	C. 53	F. 39	C. 50	F. 58	F. 52	R. 41	C. 40	F. 40	F. 44	C. 63	F. 53	F. 47	F. 63	F. 53
3	F. 37	F. 49	F. 40	C. 39	R. 44	R. 40	F. 47	F. 58	F. 46	C. 38	C. 43	C. 41	F. 45	F. 57	F. 40	F. 55	F. 63	F. 49
4	F. 40	F. 44	F. 38	F. 33	C. 40	F. 35	F. 43	F. 52	F. 45	C. 35	C. 48	F. 44	F. 32	F. 61	F. 42	C. 57	C. 64	C. 61
5	F. 35	F. 42	F. 37	C. 34	C. 42	R. 43	C. 45	F. 54	C. 53	F. 40	C. 59	C. 55	C. 45	C. 64	C. 62	C. 59	F. ?	C. 62
6	R. 41	R. 56	R. 57	C. 49	C. 57	F. 51	C. 56	C. 61	R. 59	C. 52	C. 58	F. 51	C. 62	C. 72	C. 65	C. 67	F. 72	C. 69
7	C. 49	F. 53	F. 46	F. 42	C. 49	C. 46	C. 56	F. 62	F. 53	C. 43	R. 54	R. 53	C. 57	F. 76	F. 69	F. 66	C. 77	C. 72
8	C. 39	C. 40	R. 36	C. 41	R. 43	R. 43	C. 54	C. 62	C. 58	R. 53	R. 66	R. 64	C. 70	C. 78	C. 71	F. 71	F. 80	C. 73
9	R. 38	R. 53	C. 55	R. 53	C. 62	C. 57	C. 61	C. 63	F. 60	C. 62	C. 51	C. 46	C. 71	C. 79	C. 71	C. 71	F. 79	C. 72
10	F. 65	F. 69	C. 66	C. 46	C. 44	F. 38	F. 62	C. 65	C. 49	C. 36	C. 41	F. 40	C. 48	F. 55	F. 41	C. 60	F. 62	? 55
11	C. 44	F. 45	F. 38	F. 34	C. 41	C. 40	F. 44	F. 52	F. 46	F. 32	? 45	F. 40	F. 34	F. 55	F. 37	F. 45	C. 53	R. 52
12	F. 35	F. 42	C. 40	FOG. 36	R. 40	R. 41	F. 44	F. 53	F. 52	C. 40	C. 57	C. 43	F. 35	F. 57	F. 48	F. 51	C. 65	F. 62
13	C. 48	R. 50	R. 47	C. 36	C. 45	C. 33	C. 51	C. 57	F. 50	C. 40	C. 43	C. 34	F. 45	F. 61	C. 54	F. 59	F. 68	? 59
14	R. 44	C. 38	C. 29	C. 27	C. 29	C. 26	F. 43	F. 45	C. 34	C. 29	C. 30	F. 28	F. 43	C. 46	F. 35	F. 52	F. 65	? 55

Nov., 1857.	Warrington, Fla.			Austin, Tex.			Glenwood, Tenn.			Hillsboro', Ohio.			Platteville, Wis.			San Francisco, Cal.		
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	11.45 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.
1	F. 56	F. 67	F. 57	F. 52	C. 80	F. 64	C. 38	F. 60	F. 49	F. 36	C. 48	F. 46	F. 38	F. 54	F. 45	C. 55	C. 60	C. 55
2	F. 60	F. 72	F. 62	C. 64	C. 78	F. 64	R. 48	R. 55	R. 42	F. 41	F. 52	F. 44	F. 35	C. 49	F. 33	C. 53	F. 62	C. 55
3	C. 61	F. 76	F. 68	C. 61	C. 75	C. 70	F. 31	F. 56	F. 41	F. 35	F. 49	F. 40	F. 25	F. 50	F. 36	C. 58	C. 61	C. 59
4	F. 68	F. 76	F. 71	C. 70	F. 81	F. 72	C. 41	R. 55	R. 56	F. 35	F. 54	F. 52	F. 44	C. 60	C. 57	R. 58	C. 63	C. 60
5	C. 72	F. 77	F. 72	C. 72	C. 84	F. 74	R. 63	R. 71	R. 63	C. 55	C. 59	C. 60	C. 50	C. 52	F. 50	C. 59	F. 64	F. 58
6	F. 72	F. 79	C. 72	C. 73	C. 83	C. 77	R. 69	C. 75	F. 71	C. 58	C. 62	C. 53	F. 38	C. 48	C. 42	F. 58	F. 64	F. 54
7	C. 72	C. 82	C. 73	C. 63	F. 69	F. 47	R. 71	R. 73	R. 69	F. 62	C. 69	C. 61	C. 42	C. 46	C. 44	F. 54	F. 64	F. 64
8	C. 73	R. 70	F. 70	C. 42	F. 52	F. 42	C. 63	C. 52	C. 46	C. 61	C. 64	C. 61	C. 40	C. 36	C. 31	F. 55	C. 70	F. 61
9	F. 52	F. 60	F. 50	F. 34	F. 59	F. 47	C. 40	C. 43	F. 34	C. 41	C. 38	C. 41	C. 29	C. 34	C. 26	C. 58	C. 68	F. 60
10	F. 46	F. 54	F. 43	F. 35	C. 67	C. 57	F. 30	F. 51	F. 39	F. 33	F. 42	F. 35	C. 22	F. 36	F. 28	F. 56	F. 62	F. 57
11	C. 59	F. 68	F. 61	C. 59	C. 67	R. 66	F. 32	F. 57	F. 42	F. 32	F. 46	F. 48	C. 26	C. 34	C. 26	F. 50	F. 57	F. 47
12	F. 54	F. 68	F. 60	R. 65	R. 72	R. 50	F. 37	C. 57	C. 51	F. 37	C. 48	C. 44	C. 24	C. 34	F. 25	C. 47	F. 57	F. 53
13	F. 56	F. 70	F. 62	R. 47	R. 46	R. 44	R. 48	C. 48	F. 41	C. 42	C. 42	F. 35	F. 20	C. 33	F. 16	F. 46	F. 60	F. 56
14	C. 60	C. 74	C. 62	R. 44	R. 43	R. 46	F. 32	C. 33	F. 32	C. 30	F. 34	F. 27	F. 12	F. 30	F. 20	F. 47	F. 62	F. 57

15	F. F. F. 26 32 34	C. C. R. 25 36 37	F. F. F. 31 44 40	F. C. ? 24 36 32	F. F. F. 26 49 32	F. F. ? 41 53 47	C. C. C. 60 72 65	R. R. R. 40 45 44	C. C. R. 30 43 41	F. F. F. 22 37 32	F. F. C. 22 38 30	F. F. F. 47 60 51
16	C. F. F. 35 39 37	C. C. R. 36 39 35	F. C. C. 35 47 46	C. R. C. 30 39 40	C. R. R. 39 46 45	F. C. R. 55 66 65	R. R. F. 68 67 64	C. C. F. 42 53 44	R. C. C. 46 45 42	C. C. C. 35 45 38	C. C. C. 30 36 30	F. F. F. 47 62 54
17	C. C. C. 40 55 51	C. C. C. 37 39 39	R. F. F. 52 56 46	? 36 39 36	C. F. F. 41 56 44	F. F. ? 64 62 53	F. F. F. 52 66 46	F. F. F. 38 62 51	C. F. F. 38 45 36	C. C. F. 35 39 26	C. C. F. 28 34 29	F. F. F. 50 65 56
18	F. C. F. 36 46 40	C. C. R. 36 40 38	F. C. C. 42 52 48	S. S. F. 36 41 40	C. C. C. 40 55 49	? 47 57 51	F. F. F. 44 62 50	F. F. F. 44 69 55	R. C. C. 42 53 53	C. C. C. 38 44 43	C. S. C. 30 40 20	F. F. F. 51 65 58
19	F. C. C. 37 49 45	C. C. C. 38 49 46	C. F. F. 50 59 53	R.S. R.S. F. 41 41 28	C. C. F 47 61 34	? 48 65 42	F. F. F. 62 68 56	F. F. F. 50 54 41	C. C. C. 26 21 20	C. C. C. 27 18 10	F. C. C. 0 8 10	F F. F. 53 66 51
20	C. C. C. 50 63 48	C. C. F. 30 32 25	C. C. C. 46 43 34	C. C. C. 20 24 20	F. F. F. 24 31 26	? 31 36 32	F. F. F. 40 51 38	F. F. F. 35 54 44	C. C. F. 23 26 22	F. C. C. 10 15 15	C. F. C. 12 16 12	F. F. F. 51 66 52
21	F. F. C. 35 35 35	C. C. C. 25 34 31	C. C. C. 32 40 42	F. F. 23 29 28	F. F. C. 21 38 39	? 30 43 35	F. F. F. 32 45 33	F. F. F. 38 66 51	F. C. C. 23 45 41	C. C. C. 19 26 32	F. C. F. 20 10 6	F. F. F. 49 57 48
22	C. C. F. 43 52 40	C. C. C. 31 39 32	C. C. F. 44 51 47	C. C. C. 30 29 25	F. F. C. 33 51 43	? 40 55 50	C. F. F. 52 68 62	C. F. F. 48 69 57	F. C. C. 31 44 43	F. F. C. 18 26 27	C. C. C. 4 16 8	C. C. C. 49 58 52
23	F. C. C. 35 51 56	C. C. C. 31 42 35	F. C. C. 45 56 57	C. C. ? 31 34 34	C. C F. 46 56 38	F. F. C. 53 64 56	F. F. F. 64 79 66	F. F. F. 49 63 47	C. F. F. 35 27 21	C. C. F. 34 22 10	F. F. C. —10 4 8	C. C. C. 53 59 54
24	C. C. C. 57 41 31	C. C. C. 21 29 23	C. F. C. 40 39 36	S. S. C. 18 23 22	F. C. C. 25 39 38	C. F. F. 37 50 37	F. F. F. 33 58 46	F. F. C. 36 63 60	F. F. F. 20 41 33	C. C. C. 9 21 21	C. F. F. 12 18 2	C. C. C. 54 60 55
25	C. C. F. 28 29 19	C. F. F. 6 15 12	F. F. F. 32 26 23	C. C. C. 11 18 15	F. F. F. 24 28 20	F. F. F. 34 46 37	F. F. F. 42 60 50	C. C. R. 36 67 53	C. C. F. 25 35 30	F. F. F. 10 18 13	F. F. F. —10 16 6	R. R. F. 55 58 58
26	C. F. F. 15 20 18	F. C. C. 15 26 27	F. C. C. 24 35 30	C. C. F. 17 25 21	F. F. F. 15 36 25	C. F. F. 32 46 36	C. F. C. 46 62 50	R. R. R. 51 63 61	F. F. F. 23 45 30	F. F. F. 10 27 25	F. F. F. 6 26 34	F. F. F. 55 58 53
27	C. C. C. 20 31 33	F. C. C. 25 34 34	F. F. F. 34 44 37	C. C. ? 20 37 26	F. F. F. 19 43 29	F. F. F. 32 55 45	C. C. F. 48 60 58	C. C. R. 64 75 69	F. C. C. 24 52 50	F. F. F. 21 41 35	C. C. C. 30 35 34	C. C. C. 53 59 54
28	C. C. C. 34 39 39	C. C. C. 31 38 38	F. F. F. 37 49 43	? ? F. 29 46 35	F. F. F. 23 47 32	F. C. C. 48 60 57	C. C. C. 56 67 64	R. C. F. 53 62 54	F. F. C. 47 66 58	C. F. F. 36 52 48	F. F. C. 33 48 42	R. C. C. 56 58 54
29	C. C. C. 39 35 32	C. F. F. 36 43 34	F. F. C. 42 48 43	F. C. ? 30 46 39	F. F. F. 27 56 40	C. C. C. 57 64 59	C. C. C. 66 66 67	F. F. F. 46 63 51	C. C. C. 58 59 58	F. C. C. 40 58 56	C. C. C. 46 50 48	C. C. C. 54 57 53
30	C. C. F. 29 33 28	C. C. C. 34 44 42	C. C. C. 44 46 46	C. C. C. 45 46 46	? C. C. 34 47 52	C. ? F. 58 ? 54	C. C. C. 62 70 58	F. F. F. 41 65 56	F. F. F. 50 54 40	C C. C. 49 53 44	C. C. C. 32 32 33	F. C. F. 50 58 50

Register of the temperature and face of the sky, &c.—Continued.

Dec., 1857.	Wolfville, Nova Scotia.			Montreal, Canada.			Nantucket, Mass.			Rochester, N. Y.			Alexandria, Va.			All Saints, S. C.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	C. 28	C. 43	R. 48	C. 41	C. 43	C. 38	F 48	C. 52	F. 44	C. 42	C. 40	C. 38	C. 50	F. 55	F. 40	F. 58	C. 64	F. 52
2	C. 40	C. 43	C. 39	C. 37	C. 41	C. 38	F. 43	F. 46	F. 40	C. 34	C. 44	C. 45	F. 31	C. 50	C. 44	F. 51	F. 57	F. 50
3	C. 37	C. 42	C. 37	C. 36	C. 30	C. 24	F. 43	F. 48	F. 38	C. 34	C. 34	C. 31	F. 40	F. 53	C. 40	F. 42	F. 63	F. 45
4	C. 27	C. 26	C. 21	C. 23	C. 24	F. 15	C. 36	F. 39	F. 33	C. 28	C. 34	C. 31	F. 30	C. 47	C. 43	F. 39	F. 60	C. 54
5	C. 19	C. 20	F. 16	F. 9	F. 12	F. 12	C. 34	S. 34	C. 36	C. 29	C. 33	C. 31	C. 43	C. 52	C. 45	F. 55	F. 62	C. 59
6	F. 15	F. 20	F. 18	F. 7	C. 17	S 30	C. 37	C. 40	R. 42	C. 33	C. 45	R. 44	R. 41	R. 46	R. 48	C. 60	C. 72	C. 66
7	C. 34	C 41	F. 40	F. 39	F. 42	F. 37	C. 44	F. 52	F. 43	R. 39	R. 47	R. 46	F. 38	F. 57	F. 40	F. 61	F. 64	F. 60
8	F. 39	C. 48	F. 40	C. 36	F. 43	F. 32	F. 44	C. 52	C. 48	R. 43	C. 50	C. 40	C. 50	C. 68	C. 56	C. 59	C. 70	C. 67
9	F. 32	C. 36	C. 33	C. 29	C. 34	C. 39	C. 45	C. 45	C. 53	C. 43	R. 52	C. 44	C. 63	C. 74	C. 69	F. 70	F. 77	F. 70
10	R. 42	R. 46	F. 39	C. 39	C. 37	C. 27	C. 56	C. 48	F. 40	C. 37	C. 38	F. 33	C. 52	F. 49	F. 42	C. 68	F. 64	F. 49
11	F. 33	C. 22	C. 18	C. 15	C. 16	F. 11	F. 37	F. 38	F. 28	C. 25	? 28	? 27	F. 34	C. 51	F. 36	F. 37	F. 56	F. 42
12	F. 8	C. 14	F. 13	C. 12	C. 23	F. 26	F. 22	F. 35	F. 32	22	? 31	27	F. 28	F. 38	F. 29	F. 37	F. 55	F. 46
13	C. 25	C. 36	F. 35	C. 29	C. 37	F. 36	F. 34	F. 41	F. 40	25	? 41	38	F. 22	F. 43	F. 31	C. 39	C. 53	C. 51
14	C. 36	C. 42	C. 40	C. 39	C. 41	C. 38	F. 43	F. 50	F. 42	F. 43	? 48	? 39	F. 27	F. 52	F. 37	F. 43	F. 66	F. 53

Dec., 1857.	Warrington, Fla.			Austin, Tex.			Glenwood, Tenn.			Hillsboro', Ohio.			Platteville, Wis.			San Francisco, Cal.		
	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.	7 A.M.	2 P.M.	9 P.M.
1	F. 52	F. 68	F. 56	C. 52	F. 69	F. 56	F. 28	F. 52	F. 39	C. 36	F. 43	F. 37	C. 32	C. 42	R. 40	F. 49	C. 55	F. 52
2	R. 56	F. 68	F. 58	F. 51	F. 73	F. 67	C. 42	C. 48	F. 39	C. 35	C. 45	F. 38	F. 30	F. 32	C. 27	C. 50	C. 55	F. 49
3	F. 52	F. 70	F. 50	C. 60	C. 69	F. 64	FOG. 29	F. 50	F. 36	F. 30	F. 43	F. 36	C. 28	C. 32	? 26	C. 51	F. 58	F. 52
4	F. 52	F. 70	F. 66	C. 56	C. 58	C. 58	R. 35	R. 46	R. 44	F. 31	C. 37	C. 39	C. 28	C. 31	C. 28	C. 52	C. 59	F. 52
5	F. 68	F. 70	F. 66	C. 56	C. 61	C. 60	R. 46	R. 53	R. 53	C. 39	C. 40	C. 40	C. 28	R. 35	R. 34	F. 49	F. 58	C. 52
6	R. 64	C. 74	F. 66	F. 54	F. 70	F. 53	R. 60	C. 61	F. 48	C. 48	C. 57	F. 50	R 36	C. 38	F. 34	C. 49	C. 52	F. 47
7	C. 64	C. 74	C. 68	C. 54	F. 74	F. 62	F. 42	F. 62	C. 60	F. 34	F. 49	F. 46	F. 32	C. 40	C. 34	F. 43	F. 54	F. 49
8	C. 69	C 74	C. 68	C. 60	F. 62	F. 56	R. 61	C. 69	R. 61	C. 53	C. 57	C. 57	C. 30	C. 34	C. 32	C. 46	F. 54	F. 49
9	C. 68	C. 72	C. 54	F 41	F 53	F. 37	R. 55	C. 45	F. 35	C. 59	C. 48	C. 47	C. 28	F. 32	C. 26	C. 49	C. 53	C. 52
10	F. 44	F. 58	F. 47	F. 30	F. 57	F. 40	F. 33	F. 47	F. 34	F. 29	F 33	F. 30	C. 14	C. 30	F. 26	R. 52	R. 59	R. 56
11	F. 42	F. 62	F. 48	F. 30	F. 62	F. 42	F. 31	F. 57	F. 39	F. 29	F. 37	F. 29	F. 16	F. 26	F. 18	R. 52	R. 54	R. 51
12	F. 42	F. 62	F. 47	F. 38	F. 65	F. 50	C. 31	C. 56	F. 40	F. 23	F. 33	F. 29	F. 24	F. 41	F. 28	C. 52	C. 54	F. 51
13	F. 41	F. 64	F. 43	F. 38	F. 64	F. 50	F. 33	F. 55	F. 40	F. 24	F. 45	F. 39	F. 28	F. 46	F. 40	F. 45	F. 54	F. 51
14	F. 44	F. 70	F. 45	F. 42	F. 66	F. 57	F. 32	C. 56	F. 40	F. 38	F. 51	F. 44	F. 37	C. 50	C. 40	F. 46	F. 55	F. 51

15	C. 30 F. 29 F. 19	C. 23 C. 25 C. 28	F. 41 C. 41 F. 37	C. 34 C. 49 C. 40	F. 30 F. 55 F. 42	F. 49 F. 67 F. 57	F. 48 R. 70 R. 60	C. 56 C. 60 C. 48	C. 31 C. 56 C. 44	F. 36 C. 49 F. 44	R. 40 C. 50 C. 42	C. 47 C. 55 C. 54
16	C. 18 C. 31 F. 26	C. 24 C. 31 C. 28	C. 40 C. 45 C 42	C. 37 C. 50 ? 42	C. 41 C. 50 C. 40	C. 50 C. 63 C. 57	C. 60 C. 64 C. 60	C. 54 C. 58 F. 49	C. 38 C. 54 C. 49	C. 37 C. 46 C. 41	C. 42 C. 49 C. 42	C. 52 C. 54 C. 53
17	C. 32 C. 41 C. 39	C. 28 C. 38 C 35	C. 43 C. 47 C. 4	C. 37 C. 47 C. 44	C. 39 C. 48 R. 49	C. 56 R. 63 C. 65	C. 60 F. 72 F. 58	F 41 F. 62 F. 52	R. 49 R. 50 C. 51	C. 37 C. 42 C. 45	C. 40 C. 48 C. 40	F. 50 F. 60 F. 48
18	F. 34 C. 44 C. 53	C. 34 C. 37 C. 38	R. 46 C. 53 F. 49	C. 43 C. 44 C. 33	F. 50 C. 62 F. 52	C. 57 F. 65 F. 51	C. 52 F. 74 F. 52	F. 42 F. 61 F. 49	C. 50 C. 53 C. 48	C. 40 C. 43 C. 41	C. 32 C. 34 F. 26	F. 49 F. 61 F. 56
19	C. 47 C. 32 C. 29	C. 23 S. 30 C. 30	F. 44 F. 44 F 39	C. 30 C. 29 C. 29	F. 44 F. 52 F. 42	F 45 F. 61 F. 49	C. 52 F. 74 F. 48	C. 40 C. 43 C. 44	F. 41 C. 47 F. 42	C. 37 C. 39 C. 37	F. 18 F. 36 F. 26	F. 52 C. 60 F. 52
20	C. 27 C. 29 C. 21	C. 13 C. 15 F. 12	F. 32 F. 34 F. 32	C. 27 C. 31 ? 27	F. 38 F. 46 F. 32	C. 45 C. 56 C. 53	C. 48 C. 74 C. 58	C. 43 C. 47 C. 42	C. 36 C. 47 C. 46	C. 34 F. 37 F. 29	C. 28 C. 34 C. 32	F. 48 F. 58 F. 53
21	C. 12 F. 17 F. 16	C. 17 F. 27 C. 20	F. 32 C. 40 F. 38	? 28 C. 40 C. 35	F. 30 R. 41 R. 43	C. 52 R. 53 R. 53	C. 66 F. 78 F. 54	F. 40 C. 50 C. 45	R. 48 C. 55 R. 44	C. 33 C. 41 C. 45	C. 22 C. 34 C. 26	F. 48 F. 58 F. 51
22	C. 23 R. 37 R. 42	S. 24 S. 29 C. 28	C. 45 C. 50 C. 46	C. 34 C. 34 C. 32	C. 40 C. 50 C. 40	C. 57 F. 63 C. 54	F. 52 C. 59 F. 41	C. 40 C. 44 F. 38	C. 37 C. 39 F. 34	C. 34 C. 35 F. 29	C. 18 F. 26 C. 20	F. 47 F. 58 F. 52
23	C. 32 C. 29 F. 27	S. 14 C. 25 C. 28	F. 36 C. 41 C. 41	F. 26 C. 34 C. 35	F. 36 F. 48 F. 43	F. 40 F. 54 F. 44	C. 40 C. 56 C. 48	C. 39 C. 40 C. 32	C. 30 C. 43 C. 40	F. 24 F. 36 F. 34	C. 24 C. 40 F. 30	F. 46 F. 54 C. 50
24	F. 26 S. 34 F. 15	C. 25 C. 15 F. 9	F. 41 F. 46 F. 34	C. 34 C. 22 C. 24	F. 39 F. 46 F. 36	C. 41 R. 46 R. 44	C. 46 C. 58 C. 44	F. 34 C. 45 F. 36	C. 32 C. 43 R. 40	C. 29 C. 38 C. 34	F. 23 F. 30 F. 26	C. 49 C. 50 C. 46
25	F. 9 F. 14 F. 10	F. 5 C. 12 C. 7	F. 30 C. 31 C. 36	C. 21 C. 24 C. 22	C. 34 C. 41 F. 30	C. 52 C. 43 F. 40	F. 45 F. 57 F. 43	F. 31 F. 55 F. 44	F. 32 F. 43 F. 38	F. 25 F. 34 F. 31	F. 23 C. 30 C. 25	F. 46 F. 55 C. 52
26	F. 4 F. 9 F. 10	C. 1 C. 6 C. 6	C. 34 S. 34 S. 30	C. 18 C. 24 ? 23	C. 30 C. 37 C. 36	F. 39 F. 52 F. 40	F. 44 F. 56 F. 44	F. 43 F. 57 C. 46	F. 34 F. 43 F. 31	C. 34 F. 32 F. 26	F. 16 F. 26 F. 18	F. 48 F. 55 F. 50
27	F. 2 C. 8 F. 9	F. —2 C. 5 C. 5	C. 28 F. 28 F. 22	C. 18 ? 25 ? 25	C. 26 F. 39 F. 33	F. 34 C. 46 C. 39	F. 44 F. 57 F. 41	C. 46 C. 60 C. 58	C. 29 C. 46 C. 45	F. 20 C. 34 F. 35	F. 22 C. 38 F. 33	C. 49 C. 55 C. 51
28	C. 18 C. 34 F. 36	C. 20 C. 35 F. 31	C. 37 C. 47 C. 41	C. 34 F. 38 C. 35	C. 39 R. 43 R. 41	F. 48 C. 60 C. 54	C. 52 F. 59 F. 50	C. 56 F. 61 F. 51	R. 45 R. 50 R. 48	C. 38 C. 40 C. 40	F. 20 F. 38 F. 26	C. 49 F. 54 F. 48
29	F. 28 F. 30 F. 27	C. 26 C. 29 C. 23	C. 38 C. 39 C. 36	C. 32 C. 35 ? 28	R. 41 C. 47 C. 41	F. 56 C. 71 C. 64	F. 60 F. 70 F. 59	C. 50 C. 64 C. 53	C. 50 C. 55 C. 48	C. 40 C. 42 C. 41	F. 20 C. 38 C. 30	F. 45 F. 54 F. 51
30	F. 17 F. 25 F. 21	C. 21 S. 28 S. 32	C. 39 R. 40 R. 40	C. 35 C. 39 C. 38	R. 40 R. 43 R. 40	C. 59 C. 69 C. 69	C. 60 C. 66 C. 59	F. 40 F. 57 F. 41	C. 48 C. 47 R. 42	C. 43 C. 44 C. 39	C. 23 C. 32 C. 30	F. 45 F. 56 F. 50
31	C. 25 C. 38 C. 40	S. 31 S. 27 C. 31	R. 50 C. 48 F. 40	C. 36 C. 33 C. 31	C. 41 F. 47 F. 36	C. 54 C. 56 F. 46	F. 48 F. 61 F. 46	F. 33 F. 62 F. 46	C. 38 C. 55 F. 51	C. 32 F. 37 C. 36	F. 17 C. 32 C. 30	F. 46 F. 58 F. 54

LUNAR INFLUENCES.

According to popular belief, the moon not only presides over human maladies, but, like comets, is made responsible for a vast variety of interferences upon the weather, as well as upon organized nature. The circulation of the juices of vegetables, the qualities of grain, the fate of the vintage, are all attributed to its influence; timber must be felled, the harvest reaped and gathered in, and the juice of the grape expressed at times and under circumstances regulated by the aspects of our satellite, if excellence be hoped for in these products of the soil. If these opinions were limited to particular countries, they would be less entitled to serious consideration; but it is a curious fact that many of them prevail, and have prevailed, in sections of the globe so distant and unconnected, that it is difficult to imagine the error to have proceeded from a single source. At all events, the extent of its prevalence alone rendered it a fit subject for investigation by M. Arago, who demonstrated that, so far as actual observation has hitherto afforded grounds for reasoning, there is no discoverable correspondence between the lunar changes and the vicissitudes of rain and drought, which can justify, or in any degree countenance, the popular belief so generally entertained.

The opinion that timber should only be felled during the decline of the moon, is acted upon with undoubting confidence in various countries, and is even made the ground of legislation in France, with the belief that its increase causes the sap to ascend, and, if cut during the latter period, it will contain more sap, and will, therefore, be more spongy, more likely to be attacked by worms, more difficult to season, and more readily split and warped by changes of temperature. Hence, it would follow that the proper time for felling timber would be at new moon. With a view of ascertaining whether this supposed correspondence between the movement of the sap and the phases of the moon actually exists, the accompanying table has been prepared. It will also be serviceable in making comparisons in the weather in times past, as well as in the verification of dates, and testing the recollection of witnesses in court.

EXPLANATION.

Directly under the years will be found the moon's age, change, and full, corresponding with the days of each month on the left. N, indicates new moon; F, full moon. To find the state of the moon at the period Washington crossed the Delaware, on the 25th, 26th of December, 1776, it will be perceived that it was near its full. Again, it will be observed that, at the time of the great gale in North Carolina, on the 3d of September, 1815, the moon was one day old.

D. J. B.

Table showing apppoximately, at sight, the moon's age, full, and change, from 1776 to 1889, inclusive.

MONTHS.									YEARS.																		
Jan.	Feb. Apr.	Mar.	May.	June.	July.	Aug.	Sept. Oct.	Nov. Dec.	1776 1795 1814 1833 1852 1871	1777 1796 1815 1834 1853 1872	1778 1797 1816 1835 1854 1873	1779 1708 1817 1836 1855 1874	1780 1799 1818 1837 1856 1875	1781 1800 1819 1838 1857 1876	1782 1801 1820 1839 1858 1877	1783 1802 1821 1840 1859 1878	1784 1803 1822 1841 1860 1879	1785 1804 1823 1842 1861 1880	1786 1805 1824 1843 1862 1881	1787 1806 1825 1844 1863 1882	1788 1807 1826 1845 1864 1883	1789 1808 1827 1846 1865 1884	1790 1809 1828 1847 1866 1885	1791 1810 1829 1848 1867 1886	1792 1811 1830 1849 1868 1887	1793 1812 1831 1850 1869 1888	1794 1813 1832 1851 1870 1889
DAYS OF THE MONTH.									MOON'S AGE, FULL, AND CHANGE.																		
1 31	29	30	28	27	26	25	23	21	10	21	2	13	24	5	16	27	8	19	1	12	23	4	**F**	26	7	18	29
2	30	1 31	29	28	27	26	24	22	11	22	3	14	25	6	17	28	9	20	2	13	24	5	16	27	8	19	**N**
3	1	2	30	29	28	27	25	23	12	23	4	**F**	26	7	18	29	10	21	3	14	25	6	17	28	9	20	1
4	2	3	1 31	30	29	28	26	24	13	24	5	16	27	8	19	**N**	11	22	4	**F**	26	7	18	29	10	21	2
5	3	4	2	1	30	29	27	25	14	25	6	17	28	9	20	1	12	23	5	16	27	8	19	**N**	11	22	3
6	4	5	3	2	1 31	30	28	26	**F**	26	7	18	29	10	21	2	13	24	6	17	28	9	20	1	12	23	4
7	5	6	4	3	2	1 31	29	27	16	27	8	19	**N**	11	22	3	14	25	7	18	29	10	21	2	13	24	5
8	6	7	5	4	3	2	30	28	17	28	9	20	1	12	23	4	**F**	26	8	19	**N**	11	22	3	14	25	6
9	7	8	6	5	4	3	1 31	29	18	29	10	21	2	13	24	5	16	27	9	20	1	12	23	4	**F**	26	7
10	8	9	7	6	5	4	2	30	19	**N**	11	22	3	14	25	6	17	28	10	21	2	13	24	5	16	27	8
11	9	10	8	7	6	5	3	1 31	20	1	12	23	4	**F**	26	7	18	29	11	22	3	14	25	6	17	28	9
12	10	11	9	8	7	6	4	2	21	2	13	24	5	16	27	8	19	**N**	12	23	4	**F**	26	7	18	29	10
13	11	12	10	9	8	7	5	3	22	3	14	25	6	17	28	9	20	1	13	24	5	16	27	8	19	**N**	11
14	12	13	11	10	9	8	6	4	23	4	**F**	26	7	18	29	10	21	2	14	25	6	17	28	9	20	1	12
15	13	14	12	11	10	9	7	5	24	5	16	27	8	19	**N**	11	22	3	**F**	26	7	18	29	10	21	2	13
16	14	15	13	12	11	10	8	6	25	6	17	28	9	20	1	12	23	4	16	27	8	19	**N**	11	22	3	14
17	15	16	14	13	12	11	9	7	26	7	18	29	10	21	2	13	24	5	17	28	9	20	1	12	23	4	**F**
18	16	17	15	14	13	12	10	8	27	8	19	**N**	11	22	3	14	25	6	18	29	10	21	2	13	24	5	16
19	17	18	16	15	14	13	11	9	28	9	20	1	12	23	4	**F**	26	7	19	**N**	11	22	3	14	25	6	17
20	18	19	17	16	15	14	12	10	29	10	21	2	13	24	5	16	27	8	20	1	12	23	4	**F**	26	7	18
21	19	20	18	17	16	15	13	11	**N**	11	22	3	14	25	6	17	28	9	21	2	13	24	5	16	27	8	19
22	20	21	19	18	17	16	14	12	1	12	23	4	**F**	26	7	18	29	10	22	3	14	25	6	17	28	9	20
23	21	22	20	19	18	17	15	13	2	13	24	5	16	27	8	19	**N**	11	23	4	**F**	26	7	18	29	10	21
24	22	23	21	20	19	18	16	14	3	14	25	6	17	28	9	20	1	12	24	5	16	27	8	19	**N**	11	22
25	23	24	22	21	20	19	17	15	4	**F**	26	7	18	29	10	21	2	13	25	6	17	28	9	20	1	12	23
26	24	25	23	22	21	20	18	16	5	16	27	8	19	**N**	11	22	3	14	26	7	18	29	10	21	2	13	24
27	25	26	24	23	22	21	19	17	6	17	28	9	20	1	12	23	4	**F**	27	8	19	**N**	11	22	3	14	25
28	26	27	25	24	23	22	20	18	7	18	29	10	21	2	13	24	5	16	28	9	20	1	12	23	4	**F**	26
29	27	28	26	25	24	23	21	19	8	19	**N**	11	22	3	14	25	6	17	29	10	21	2	13	24	5	15	27
30	28	29	27	26	25	24	22	20	9	20	1	12	23	4	**F**	26	7	18	**N**	11	22	3	14	25	6	17	28

INDEX.

Office
ral Report
1857

RECEIVED

RETURNED